AGRICULTURAL ENGINEERING

Published monthly by the American Society of Agricultural Engineers

Publication Office, Bridgman, Michigan. Editorial and Advertising Departments at the Headquarters of the Society, Saint Joseph, Michigan

Subscription price to non-members of the Society, $3.00 a year, 30 cents a copy; to members of the Society, $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates are not applicable, $1.00 additional. Entered as second-class matter, October 8, 1925, at the post office at Bridgman, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921. The title AGRICULTURAL ENGINEERING is registered in the U. S. Patent Office.

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Vol. 8 MAY, 1927 No. 5

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

Vol. 8 MAY, 1927 No. 5

Relation of the Agricultural Engineer to the Dairy Industry

By A. W. Farrall[1]

THERE appears to be a good field for the agricultural engineer in applying engineering principles to the dairy industry, for as yet there is much hand labor involved, especially in the milking and feeding operations. There are also a number of very careful and exact treatments which must be given the milk and the milking equipment, in order to produce the best quality. The industry has already, through the attention of progressive dairymen and dairy leaders, done considerable toward providing machinery necessary for the proper handling of milk, but this is far from universal. There are also numerous problems which arise to prevent the successful application of machinery in all cases.

The relation of the agricultural engineer in respect to dairying is that of being the medium whereby mechanical means is made to do the work now performed by hand labor; also to improve methods, to remove drudgery, to increase quality, and to reduce the cost of production. He might also be called the efficiency man, for it is his function to check up on the different operations as they are now performed and determine whether or not, when examined in the light of the best engineering practice, they could be improved upon. This relationship might be more clearly shown by an analysis of the operations which are performed on a modern dairy farm and the different phases which must be considered. In all of these different phases the agricultural engineer can find some place where his training might fit him to render service to the dairy farmer.

He might assist by either advising the farmer through personal contact, news articles, radio talks or bulletins concerning the proper methods or equipment which should be used, or he might help in some cases by analyzing the existing methods of operation and machines used, test the principles involved and possibly develop new methods or principles or ways of doing the thing at hand.

Some of the phases of the dairyman's problem which should be considered are as follows:

1. **Farmstead Layout and Planning of Buildings.** Attention to this phase would reduce the labor requirement to a minimum in the caring for animals and equipment. The arrangement of corrals, milking barns, feed yards, etc., the use of labor-saving devices, such as easily operated gates, assist in cutting down the labor requirement. The proper selection of materials of construction is also important.

2. **Equipment Used in the Production of Feed.** In addition to the regular farm machinery equipment there are oftentimes special types of hay stackers, hay loaders or special harvesters which can be applied.

3. **Equipment Used in Handling and Caring for Animals.** The use of self-feeders, automatic motor-driven feed grinders, water supply systems and sanitary equipment are fields in which the agricultural engineer is qualified to act. He may also cooperate in the control of flies by mechanical means. The sewage disposal problem is also important.

4. **The Milking Operation.** It is desirable that the relative merits of hand and machine milking be known, also that factors affecting the efficiency and successful use of mechanical milking machinery be determined. There is a big field in the matter of developing better methods of caring for the milking machine.

5. **Refrigeration.** The knowledge of the method of the operation of a refrigeration machine should be more universal. There is room for development of a less complicated and more inexpensive method of refrigeration for the farm. There is also a need for more information concerning best types of coolers and cold storage house construction.

6. **Sterilization of Dairy Equipment.** A comparison of various methods of sterilization of dairy equipment, together with the testing and design of the various types, such as oil, electricity

[1]Division of Agricultural Engineering, University of California. Assoc. Mem. A.S.A.E.

The production and manufacturing of dairy products involves engineering to a large degree. It is one of the most fertile of the fields open to the agricultural engineer, for the application of the engineering knowledge and experience which he possesses. This picture shows a mechanical refrigerating outfit for cooling milk on the farm of Owen D. Young, chairman of the board, General Electric Company

and gas heated sterilizers is important. There is also information needed regarding improved means for washing dairy utensils. The possibility of the use of solar heat should also be considered.

7. **Transportation of Milk.** The agricultural engineer can assist in developing means for satisfactory long-distance transportation, giving special attention to the maintenance of the quality of the milk and reducing the cost of transportation.

8. **Organization of the work.** This is more or less of a farm management problem, but at the same time the agricultural engineer should be able to so organize the work that all machinery is used in the most efficient manner possible and that the proper equipment is used in all cases.

The agricultural engineer should be able to analyze the above named phases of the work; namely, the farmstead layout, equipment used in the production of feed, equipment used in caring for animals, the milking operation, the cooling or refrigeration, sterilization of utensils, transportation and organization of the work, and determine where, by the use of better engineering construction or principles, more satisfactory and economical work could be done. The agricultural engineer then could perform his service to the farmer in two ways: First, making available to the farmer authentic information which is now known but is not in the hands of the farmer, and, second, by studying the principles involved and developing entirely new methods or machinery where improvements could be made. This includes the design of special equipment such as sterilizers, and structures such as milking barns and milk houses, keeping in mind at all times the farm conditions under which they are to be used.

A Flail Type Harvester For Sweet Clover Seed

By G. E. Martin[1]

IN THE course of my extension work in agricultural engineering in Oklahoma I encountered an interesting example of orginal, constructive agricultural engineering which seems worthy of more extended application. The idea may have been developed and applied elsewhere independently, but it is my opinion that credit for original work belongs to Paul Stritke, a farmer located near Oolagah, Oklahoma. After seeing the Stritke machine Brashear Brothers, Watova, Oklahoma, built a similar machine embodying some minor improvements.

As will be seen from the accompanying illustration, the flailing sweet clover seed harvester has for its foundation the wheels, frame, and platform of an old grain binder. The one built by Mr. Stritke was made from a binder of the 6-foot size. On, or in place of, the platform is built a large housing or seed-catching box. The construction of the reel or beating cylinder is so well shown in the illustration as to call for no specifications other than that its diameter is six feet.

As will be seen, the drive is direct from the bull wheel sprocket to the small sprocket on the beater shaft. In the absence of exact data as to the sprocket ratios and wheel diameter, the speed at which the reel is operated can only be approximated by the proportion of parts as they appear in the photograph. In fact, it is doubtful if the optimum speed for the reel, or its ideal diameter, has yet been worked out accurately. The sprocket on the reel shaft embodies a jaw clutch for throwing the reel in and out of gear.

On the Stritke machine there is a door in the back of the seed collecting box for removal of the seed, while in the Brashear machine the entire back panel is made so that it can be raised.

It is understood, of course, that the sickle is not used, the revolving reel simply beating the seed from the standing plant without severing the stalks. As to efficiency, there have been no accurately controlled tests conducted. Mr. Stritke is of the opinion that it saves from 70 to 80 per cent of the total yield if the seed is fully ripe and dry, the conditions under which this machine should be used, but he goes on to say that an accurate estimate of absolute efficiency is impossible because there is no machine or method of harvesting which will gather all the seed, consequently there is no way of telling how much seed there is in a field.

Next to this machine Mr. Stritke thinks the regular binder used in the ordinary fashion is the best means of harvesting, but with the binder there is the additional expense for twine, shocking, threshing, and for handling of the threshed straw. Whereas with the harvester here described the material is right on the ground where it is wanted for soil improvement. With the ordinary binder it is necessary to cut only when the material is damp, to hold losses by shattering to a minimum. With the flailing harvester the work may be done at any time that the sweet clover plants are dry, as a maximum of shattering is precisely the thing which is wanted. It would seem that with the new machine the large, plump, fully ripened seed would be the easiest to save, with losses occurring chiefly in the immature and less desirable seed, whereas with the ordinary binder the conditions are exactly the reverse.

A further advantage of the new method arises from the fact that the seed as harvested is perfectly dry and in condition to be stored and keep without heating and other difficulties—a rather important point because heating from dampness is a serious matter with sweet clover.

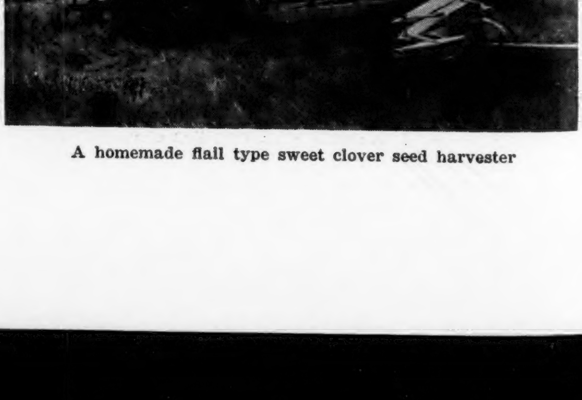
The users of these seed harvesters estimate that the draft is approximately equal to that of an ordinary binder, the draft in either case fluctuating with the heaviness of the crop. With a 6-foot machine drawn by horses the working capacity is from eight to ten acres a day, the capacity being reduced by the necessity for stopping to empty the accumulated seed into a wagon.

So far as is known, these machines have not been tried for harvesting alfalfa seed, but they have been used with satisfaction on soy beans.

[1]Extension Agricultural Engineer, Oklahoma A & M College. Assoc. Mem. A.S.A.E.

How the Combines Saves Labor

THE "combine" system of harvesting small grain, so called because it combines harvesting and threshing in the same trip over the field, is the greatest cost cutter yet introduced into the farming system. Kansas now has 8,274 of these machines in use and will add more than two thousand the coming year, according to Kansas State Agricultural College authorities. More than 30,000 itinerant harvest hands have been eliminated as a result, each machine eliminating three high-priced harvest workers and permitting the farmer to handle his harvest without outside help. With nearly 30,000 such machines estimated in use in the United States at the present time, at least 90,000 "imported" harvest workers will be kept off the farm in the 1927 harvest.



A homemade flail type sweet clover seed harvester

Rural Electrification in Europe*

By E. A. Stewart[1]

IF LITTLE Tommy doesn't have any toys or at the most only a few old ones inherited from an older brother, it is rather easy to get him to play with a new toy. On the other hand, when Tommy has good toys, it is frequently difficult to get him to play with new ones, and in fact, we find him very often going back to play with his old familiar toys. This trait of mankind accounts for the fact that rural electrification in Europe has made such rapid strides in the last twenty years, and very great advance in some countries in the last ten years, while it is more difficult to extend rural electrification in America. The European farmer of ten or twenty years ago had very little power of any kind, and an exceedingly small amount of mechanical power. Electricity for the European farmer has meant not simply supplying his farm with light, nor replacing one type of power with another, but in many cases it provides the first mechanical power that his farm has ever had. The American farmer is now using more than four times as much power per farm worker as the farmer of continental Europe, and approximately 50 per cent of this is mechanical power. Gasoline engines or steam engines are used to a very limited extent in most of Europe. Only larger farms have been using much mechanical power.

It can readily be seen that the introduction of electricity in European countries is a different problem than in America. In the first place, the area of the United States is almost equal to that of all Europe. Many European countries are not so large as one of our average states and indeed some of them are not so large as a fair-sized county in this country. While rural electrification has progressed rather rapidly during the last few years in Germany, Sweden, Norway and Denmark, a comparison shows that less than 5 per cent of the farms of all Europe have electric service, which is about equivalent to the percentage electrified in the United States.

The type of farming, together with the habits of living and housing, influences very much the ease with which electricity has been introduced into most rural districts in Europe. In Germany the majority of farmers do not live on their farms. The farm homes and barns are in villages of eight to twenty-five homes; in a drive of forty miles around Bernau, we found only two isolated farmsteads. A majority of the homes in the villages have electricity. Some new installations were being put in this summer. The grouping of farm homes exists to some extent in southern Sweden, in Denmark, Holland, Belgium, France, and Switzerland. In all of these countries the distribution problems of rural electrification are somewhat simpler than here. In practically all of Europe, the British Isles included, rural towns did not have electric service, before a move was started to obtain electric service for the farmers. This condition accelerated the growth of service for farms as service for both was developed as one project. The only countries, which have housing conditions similar to those in America, are central Sweden and the British Isles. Practically no farm electrification exists in most of Great Britain and Ireland, except in northwest England and southern Wales, where there may be about five hundred farms receiving electric service. The electrification, therefore, of central Sweden is in the only region where farm conditions are comparable to those in America.

The type of farming influences the ease with which electrification of the farm may be brought about. Very few farmers in Europe specialize on some type of farming as they do in America. Mr. Velander, of Malmo, Sweden, explained the situation when he said, "The only difference between our large farms and our small farms is that the large farms have more cattle, more horses, and more of each kind of crop, but all in one community will have about the same kind of stock and raise very much the same crops." The farmers of Switzerland raise dairy cattle and hay mostly. This may be supplemented by roots, and some small grain on the flat land farms in the valley bottoms. France raises more grain and in larger acreages than any other country of western Europe. Northern Germany and southern Sweden raise a considerable amount of grain, but generally on a smaller scale of farm operation, and quite widely distributed. A very large amount of livestock is kept on all farms throughout western Europe with the exception of France.

There are two psychological factors which have aided in making rural electric service possible in Europe. The large amount of water power available for the generation of electricity is one influence. However erroneous the idea may be, it remains a fact that most people believe that electricity from water power ought to be cheap energy. This has been a dominant idea in Europe. Another factor is the type of thinking quite prevalent in most of Europe. Most of the people are accustomed to centralized authority, and readily accept

*Journal Series Paper No. 661, Department of Agriculture, University of Minnesota.

[1]Division of Agricultural Engineering, University of Minnesota.

(Left, above) Threshing with a 15-horsepower motor near Bernau, Germany; this machine also bales the straw. (Left, below) A 25-ton truck carrying a 100-horsepower electric motor used in connection with a double-haulage plowing system in France. (Center) Mr. Grunthard, of Zurich, who has a very completely electrified farm, shown standing by an electric vegetable and fruit cooker. (Right) A transformer station in Switzerland

what engineers decree they should have. Many of the farm people in Europe are accustomed to thinking collectively, which makes the problem simpler than here where our people are accustomed to thinking individually.

Electrification in Europe. When the type of farming and the type of housing are taken into consideration, it can readily be understood why more farm houses are lighted by electricity in Germany than in any other country. Accurate data for Germany are not available. Mr. Petri, of Stettin, stated that about 90 per cent of all land in Germany is in districts where electric service is available without extending high-tension lines. Mr. Petri thinks that about 80 per cent of all farm homes have electricity. Mr. Peirce, of the International General Electric Company, reports that approximately 70 per cent of the farm homes, mostly in small villages, have electric service. In Germany and some other parts of Europe it is necessary to speak of farm homes and barns rather than of farms, as the farms are not generally located where the buildings are. In fact, it is not unusual to find electric service used for lights in the house only, the barns being without lights. Some such farms may have a power connection in the yard, but no wiring in the barns.

Any accurate data on the number of farms that are electrified are not available, but estimates, as given by several men in each country, who are familiar with electrification, are as follows:

Percentage of Farms Having Central Station Electric Service

Germany	60 to 70 per cent
Sweden	40 to 45 per cent
Norway	40 per cent
Denmark	35 per cent
Switzerland	10 per cent
France	5 per cent
All Europe	Less than 5 per cent

The cost of extending electric service to farms is dependent more on area than on the number of consumers to be served, while the income is more proportional to the number of consumers. While the percentage of farms served, as shown in the table above, appears large, the area served is small, because several of these countries are not larger than single states in America.

Data for the United States, Europe, and several countries in Europe are given in the table below. Data in the first column represents total land area; in the second column, total area in farms, and in the third column, the approximate area in farms operated by farmers who have electric service.

Total Area, Farm Area, Electrified Area in Different Countries

Country	Total Area (sq. mi.)	Farm Area (sq. mi.)	Electrified Area (sq. mi.)
Germany	181,524	104,800	83,000
France	212,662	198,000	8,000
Sweden	173,075	21,000	12,300
Norway	124,964	11,500	6,700
Denmark	17,900	13,500	6,500
Switzerland	15,976	6,000	800
Europe	3,800,135	2,350,000	120,000
California	188,981	46,500	31,000
United States	3,615,600	1,490,000	76,500

A comparison of the data given in this table shows that Germany is not so large as California, and in fact, the total farm area of these six European countries, which are the only ones where there is much rural electrification, is less than the total area of the three states of California, Oregon, and Washington. When a comparison of electrification in Europe and America is made, therefore, it must be remembered that whole countries in Europe are like states in America. The percentage of the farm area electrified in Europe and in United States, as given by the ratio between the electrified area and total farm area, is found to be about the same for both, namely 5 per cent. We must remember, also, that approximately as many farms in America have private electric lighting plants as have high-line service, while only a few private farm electric plants are found in Europe.

Purpose of Rural Electrification. Some difference in the reasons for extending electric service to farms in different countries has been implied in the preceding paragraphs. One of the principal reasons for developing rural electric service in Switzerland and Germany has been to replace manual power with mechanical power for farm operations. This same motive has been a prominent factor in furthering its development in Sweden, Norway and Denmark, although that was not the principal motive for starting rural service in these countries. Faaborg Andersen says, "Farmers of Denmark soon found it profitable to replace manual labor by electric power for such work as threshing, fodder cake crushing, milking, water pumping, etc." The need of mechanical power for field operations, that is not dependent on costly oils or coal from other countries for fuel, is the cause of so much activity and effort at present to make electric plowing a success in Italy, France and Sweden.

The most urgent need for rural electric service in Sweden and Norway was for lighting. This became a very dominant factor during the days of the world war, when many homes could not secure oil for lighting and had to resort to candles. The accompanying graph shows how rapidly electric service increased in Sweden during the war period and immediately after. It is amazing that sufficient capital was obtained to bring about the electrification so rapidly.

The need of electricity for lighting was one of the principal factors which encouraged the extension of rural electric service in Germany. Most of the rural electrification in Germany was carried out before the world war, and it was promoted in order to increase the efficiency of the farmers by supplying mechanical power to replace animal and human power on the small farms.

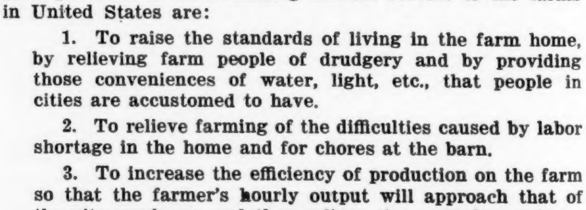
France at present is attempting to further rural electrification and has granted some subsidies, as has Italy and other countries, to aid in building rural extensions. While many of the reasons given for extending rural electric service apply to the case in France, there may be others. One Frenchman said, "We must have two armies, one to fight for us and one to feed us, and both must be raised on the farm. Farming is so unprofitable and country living is on such a low scale that the government must do all that is possible to make farming better and to keep people on the farm. Electricity will help wonderfully in doing this."

Practically none of the reasons that brought about rural electric service in Europe exist in the United States. The principal reasons for extending electric service to the farms in United States are:

1. To raise the standards of living in the farm home, by relieving farm people of drudgery and by providing those conveniences of water, light, etc., that people in cities are accustomed to have.
2. To relieve farming of the difficulties caused by labor shortage in the home and for chores at the barn.
3. To increase the efficiency of production on the farm so that the farmer's hourly output will approach that of the city workman and thus relieve the agricultural financial depression.

Rural electrification in America, therefore, must be handled in a much different way than it has been handled in Europe.

Rates or Tariffs. The problem of rates is very urgent. Men in several of the countries are trying to find a proper type of rate. The rates in effect vary a great deal in different parts of the same country and between different countries.



Graph showing the development of rural electrification in Sweden up until 1927

Several types of rates are in use. Some rates are a flat charge per year, some are of the minimum bill type, and some are of the fixed charge type which includes a certain quantity of energy and then an energy rate. None of the countries has a fixed charge based on cost, which covers all fixed costs, and then a low energy rate such as has been recommended for rural service in this country. In one district in Sweden, the rates are $3.00 per year for each 25 c.p. lamp, no energy being measured where less than twelve lights are installed. On larger installations, the fixed charge consists of three parts: $1.00 per year for each lamp, $1.50 per year for each horsepower of connected motor load, and 37½ cents per year for each acre of cultivated land. The energy is then sold at 6 cents per kilowatt-hour. In this instance the company pays all costs of the rural extensions.

In Switzerland, the schedule of rates sometimes consists of three parts—for light, power, and cooking. The rates for all three are on a sliding scale for the energy used, and then the light and the cooking rates may be under two schedules for day and night use. Meter installations for handling such complicated schedules are very expensive—as high as $150.00 in one farm home. On the light rate, the energy costs are: For the first 500 kilowatt-hours per year, 10 cents per kilowatt-hour; next 1000 kilowatt-hours per year, 8.6 cents per kilowatt-hour.

The demand charge on motor load is from $8.00 to $12.00 per year per horsepower, and the energy costs: For the first 500 kilowatt-hours per year, 3.2 cents per kilowatt-hour; next 1000 kilowatt-hours per year, 2.8 cents per kilowatt-hour; above 10,000 kilowatt-hours per year, 2 cents per kilowatt-hour.

Energy for cooking is sold at two cents per kilowatt-hour and the demand charge for a 6-kilowatt range is $25.00 per year. Energy used at night through double-schedule, time-operated meters is sold at about one-half of the rates for day service. In some parts of Switzerland, the rates are cheaper in summer than in winter, which further complicates schedules.

In one installation in England the rate consists of a fixed charge of 50 cents per pound ($5.00), or part of one pound, of rateable value of the consumer's buildings per annum, a further fixed charge of 62½ cents per horsepower of connected motor load per quarter year, and the energy is sold on a sliding scale as follows:

For the first 1,000 kilowatt-hours per quarter, 5.0 cents per kilowatt-hour; second 1000 kilowatt-hours per quarter, 4.5 cents per kilowatt-hour; third 1,000 kilowatt-hours per quarter, 4.0 cents per kilowatt-hour; fourth 1,000 kilowatt-hours per quarter, 3.5 cents per kilowatt-hour; excess kilowatt-hours per quarter, 3.0 cents per kilowatt-hour.

Since the average rateable value per farm is about 35 pounds, then a farmer having a 5-horsepower motor has a fixed charge of $30.00 per year.

In central Sweden where the farmers' cooperative organizations buy electricity from the Royal Waterfalls Board (state owned) and distribute it over the lines owned and maintained by themselves, the farmers pay a fixed annual charge of 35 to 55 cents per acre of cultivated land (about $16.00 for each farm of 40 acres), and a minimum bill of $84.90 per year for a one-kilowatt average demand, which entitles the consumer to about 3600 kilowatt-hours. Energy in excess of this amount is sold at about 2 cents per kilowatt-hour.

It is quite interesting to find that regardless of the type of rate used, the average energy price is approximately the same in several of these countries. In a survey made at Chester, England, the average rate was found to be 6½ cents per kilowatt-hour. In a survey from Switzerland, the average rate was 9.3 cents per kilowatt-hour and on one large farm near Berlin, the average energy rate was 6 cents per kilowatt-hour for an energy consumption of 3760 kilowatt-hours per year. In central Sweden the average price is about 9 cents per kilowatt-hour, and in southern Sweden where energy consumptions are larger the average rate is about 6 cents per kilowatt-hour. Wherever there is no fixed charge the energy rate is high, but in Sweden, England, Norway, and Switzerland where there are adequate fixed charges, the energy rates are low.

Energy Consumed. The amount of energy used per farm is a real criterion of how much use is made of electric service. In the European countries they are inclined to place emphasis on the amount of energy used per hectare (2.47 acres) of cultivated land as a measure of the effective use of electricity in agriculture. Another method used frequently for comparison is the consumption of energy per head of agricultural population. The latter method involves both factors, the percentage of farms electrified and the effective use per farm. The former method assumes that large farms will use about as much in proportion to size as smaller farms use. This may be so in Europe where the large farm is more or less like several small farms combined. In the United States the large farm which is not similar to the small farm, either in produce raised, or in method of operation, may use less energy than the small farm. It appears that a comparison of energy consumed per farm is a better measure of the effective use of electricity for the United States.

The data given in the table below show for different countries and different states a comparison of the energy consumption per farm and per acre of cultivated land on the farms where electricity is used.

The data for central Sweden, given at the conference at Basle, probably represent about the average condition for all of Sweden. The data for Germany and Switzerland, taken from the general reporter's paper at the conference, represent averages for those countries. The data for Norway are taken from a survey of 391 farms located in the best agricultural district of Norway. They show to what extent electrification may be carried under intensive development, and do not represent the average for the country. The data for Red Wing are taken from experimental work being conducted on a group of farms by the University of Minnesota, and show what results may be secured by intensive development under the present state of electrification. The data for Illinois and Washington are taken from recent surveys and show about the average energy consumption in a diversified farming community where no special effort has been made to develop its use. The data for California are approximate, and show what can be expected where rural electrification is developed intensively, and for special uses like irrigation, poultry plant operation, etc. The average energy consumption for the whole United States is probably about twice what is given for Illinois.

The small size of the average European farm indicates that only short lengths of line will be required to serve each farm. In one large district of 4,000 electrified farms in Sweden, about ⅛ mile of low-tension line at 500 volts (four-wire, three-phase) and about 1/20 mile of medium-tension line at 3,000 volts (three-wire, three-phase) is required per farm. In one district near Bernau, Germany, there were on an average about twenty-two consumers in each small farm village, and the villages were about 2½ miles apart. Under such conditions the delivery charge (or fixed charge) per customer is very low. The reduction in this charge is greater than simply the ratio of mileage per customer, because such a high density of consumers makes it possible to use a simpler type of distribution system, cuts down the number of transformers on high-tension lines by serving several customers from one bank of transformers, and thereby reduces original investment, maintenance costs, and energy losses. This reduces the fixed costs per customer to about 15 to 25 per cent of the costs that would prevail in this country, even if prices of labor and material were the same. In one group in Sweden, the cost of high lines, transformers, and secondaries to supply

Electrical Energy Consumption

Country	Sweden	Germany	Switzerland	Norway	Red Wing, Minn.	Illinois	Washington	California
Ave. size of farm, acres cultivated	22	14	22.5	51	156	91	43	100
KWH per year per farm	266	200	350	4300	3000	751	912	14,400
KWH per year per acre	12	14	15	84	19	7	21	144

farm service was $92.00 per customer, while the average cost for Ontario is $344.00, and for central United States is $485.00 per customer. This low cost per customer has had a great deal to do in facilitating the extension of electric service to farms in Europe.

Because of the small consumption of energy per farm and because of low fixed costs as just explained, the average yearly cost for electrical energy is not high. Wherever the energy consumption is large, however, the costs are fairly high. On the 391 farms referred to in the survey made in Norway, the average yearly costs for electricity were $132.00 per customer; for the larger farms of about 125 acres, the average costs were $257.00 per year. On small farms where electricity is used for little except lighting, the cost is from $24.00 to $30.00 per year. In Switzerland, the cost of electric service will run about $71.00 per year per farm. In Sweden the average annual cost is said to be about $45.00 per farm, while one farm of 250 acres, which I visited, used about 17,000 kilowatt-hours last year at an annual cost of about $445.00.

Uses of Electricity. The greatest use of electricity in agriculture in all of Europe is for lighting, although some of the other applications are now using more energy.

The large amount of energy used in motors in Sweden is accounted for chiefly by their use for threshing. It has been estimated that 50,000 threshing rigs are operated by motors in Sweden. This has become the most important application of electricity in Sweden. Other very important uses for motors are in driving machines for hoisting hay and for chopping hay and fodder. No other uses are nearly so general as these three. Other uses are for sawing wood, grinding feed, chopping roots, pumping water, pumping manure, grain cleaning, and dusting peat for bedding. Electric cooking is becoming an important application. In Norway and Switzerland this is the most important application of electricity. Very few ranges are used, but nearly ever farm in these two countries has one or two hot plates. Several farmers are using electric food cookers for preparing hog feed. Domestic applications are restricted mainly to cooking, and to the electric iron. A very small number of washing machines, vacuum cleaners, ironers or other household equipment are in use in farm homes. Electric water heaters are being used to some extent, where a cheap rate for energy used at night is in effect. These are practically all storage heaters. Water is pumped by electric motors on probably less than 5 per cent of the farms. In fact in some districts there are more electric water heaters than electrically operated water pumps.

Some of the special uses are very interesting. The electrically operated plows are being given more attention than any other application. Such plows are being tried in England, Sweden, Germany, France, and Italy. Italy and France seem to be the most progressive in this work and are now organizing electric plowing on a commercial basis. Several outfits are in use in each of these countries. The electrical heating of ensilage has been used in Germany, Switzerland, Denmark, and Sweden. It is estimated that about 3000 electric silos have been installed in Germany. There are many uses that are being experimented with and promise to be practical applications. The use of electricity to heat the ground in cold frames in Sweden and Norway has now reached a practical stage. Grain drying and electro-plant culture appear to be possible future uses. The experimental work is progressing satisfactorily.

The portable motors of all sizes and the portable transformer trucks for large motors are well developed in Europe and offer good examples. Wiring devices for good installations on farms have been produced and used. Many special pieces of agricultural equipment such as root choppers, fodder choppers, etc., have been developed for electric drive.

Ownership of Electric Utilities. Private, municipal, and cooperative ownership of electrical producing and distributing properties is very much mixed up in Europe as it is in America. Many large systems of distribution are under private ownership and many under public ownership. The condition in Sweden perhaps is typical. The state-owned power stations represent about one-fourth of the total developed power. There are thirteen privately owned, and nine state or municipally owned power generating stations. Part of the rural distribution is handled under cooperative management by the farmers, and a very large part is by direct distribution by the power companies. The concensus of opinion of many engineers is that the tendency is toward company operation of rural lines. Many engineers take a very determined attitude against cooperative ownership and operation of rural lines because of the technical and complex nature of the business.

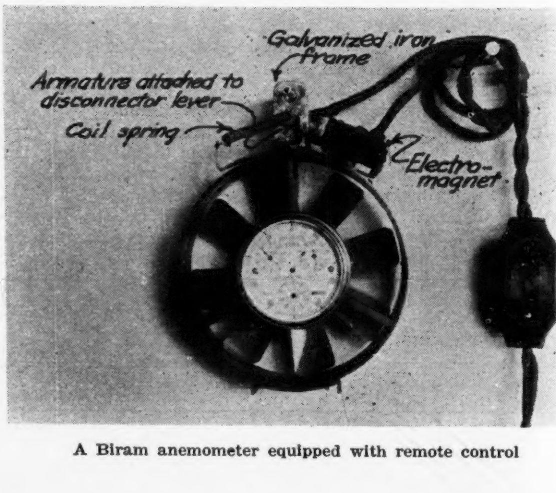
Remote Control for Anemometer

By Geo. W. Kable[1]

ONE of the problems encountered in studying prune and hop driers in Oregon was the measurement of air velocities in places which were too small or too hot to enter, or where an object as large as a man's body would so upset the regular flow of air as to make measurements valueless. In order to overcome the difficulty a magnetic control for an anemometer was devised and built in the field. Although rather crude, the device has been in satisfactory use for two seasons.

The Biram anemometer is regularly equipped with a ring fastened to the top of the housing by two screws. This ring was removed and replaced by a frame made of a single piece of galvanized iron having a spring support arm shown at the left in the accompanying illustration, a double bail in the center and a rolled core for an electromagnet at the right. The terminals of the electromagnet winding were attached to binding posts on the frame. A galvanized iron armature was soldered to the disconnector lever as shown, and the anemometer indicator held in disconnected position by a small coil spring.

In use the instrument was hung on a nail in the end of a lath, or otherwise, at the point where the air movement was desired. Lamp cord attached to the binding posts was carried out of the dehydrator tunnel. A feed through switch and three cells of dry battery completed the outfit. When conditions inside the dehydrator had become normal, the switch was closed and the anemometer started recording the air movement. The record was stopped after an accurately timed interval by again snapping the switch.



A Biram anemometer equipped with remote control

[1]Agricultural Engineer, Oregon Agricultural College. Mem. A.S.A.E.

Irrigation in Relation to Soil Moisture and Plant Growth*

By F. J. Veihmeyer[1]

THESE studies have to do with the behavior of soil moisture as regards its movement in the soil due to capillarity, evaporation from exposed soil surfaces, and the reaction of certain plants to different amounts of soil moisture under California conditions. The findings are rather sharply at variance with the preponderance of previously existing views on these subjects.

Two closely related and widely held beliefs are that the capillary movement is sufficiently rapid to be effective in moving moisture from moist soils to drier soils in appreciable quantities, and that a mulch of loose soil produced by cultivation is more or less effective in checking surface evaporation. An important point at issue is whether the evaporation losses are confined to the surface layers of soil or whether moisture moves upward from lower layers and is subsequently lost by evaporation.

Records taken from experiments under humid climate conditions show that much of the rain which falls on the soil is returned to the atmosphere by evaporation. There is reason at least to suspect that these relatively large losses of moisture are due to the fact that rain comes in small amounts and does not penetrate deeply into the soil, but remains close to the surface in what might be called an evaporation zone. Further, the light rainfalls occur in the warmer parts of the year when the evaporating of the air is high. In contrast, under arid or semi-arid conditions in the West, rains usually come when atmospheric evaporating power is low, and the rainfall which occurs though slight in amount has an opporunity to penetrate into the soil to considerable depths. Under usual irrigation practice water is applied in sufficient amounts to wet the soil deeply, so that the portion of it which remains in the surface layer and is subject to rapid evaporation constitutes but a small part of the total amount applied.

The results of the experiments herein reported indicate that, when soils are not in contact with free water, capillary movement is extremely slow in rate and slight in extent. This is illustrated by Fig. 1 which shows the amount and extent of moisture movement upward and downward from a layer of soil containing its maximum field capacity of moisture into other layers of soil materially drier but above the wilting coefficient. It will be noticed that the movement of moisture extended only about 8 inches both upward and downward in a period of 139 days. Similar results have been obtained in many other trials with soils of different initial moisture contents, and are supported by repeated field observations.

To investigate the losses of moisture from irrigated soils and to determine the influence of cultivation on such losses clay loam soils were packed in tanks containing from one-half to three-fourths of a ton of soil, the tanks being arranged in trenches (Fig. 2) alongside a platform provided with portable derrick and suspension scales for the convenient weighing of the tanks and contents as the investigation proceeded. Water was applied to the surfaces of these soils and as soon as they were dried enough to permit doing so some of the tanks were cultivated weekly throughout the test, while in others the soil was undisturbed except to remove weeds. The losses of moisture in pounds per square foot of soil surface exposed are given in Table I. It will be noted that cultivation had a negligible influence on the amount of evaporation, that the total loss in eighty days was equivalent to only 1.8 inches, (one pound of water to the square foot is about 3/16 inch in depth), and that approximately one-half of this loss occurred within the first week after the water was applied. It was noted in these and many other experiments that the rapid loss of water by evaporation during the first few days following the application of water took place chiefly before the soil was fit to cultivate, casting serious doubts on the efficacy of cultivation as a means of reducing evaporation losses.

Trials to determine the loss of moisture by evaporation from the soil were made also with field plots on different soil types and at different points in the state, namely Davis, Mountain View, Delhi and Whittier, representing a wide range of climatic conditions. At each place there were four plots, two cultivated and two not, so that all observations were in duplicate. Representative results from among these tests are given in Tables II, III and IV. The general results are that there are no real differences in soil moisture behavior between the cultivated and uncultivated plots and that no significant loss of moisture occurred from the soil depth zone of 3 to 6 feet. Sampling showed that the losses were confined almost entirely to the surface foot of soil, that these losses occurred largely in the upper 8 inches and that of this latter the greater portion was from the first four inches.

In sharp contrast to the extremely small and slow loss of soil moisture by evaporation from the surface is the amount and rapidity of moisture dissipation by transpiration from growing plants, as shown by comparing the two in soil-tank tests. For example, a tank containing a four-year French prune tree, with the soil covered to eliminate almost entirely losses by evaporation from the soil surface, used 1250 pounds of water from March 1, 1922 to November 4, of the same year. A similar tank packed with the same kind of loam soil, wet throughout its depth at the beginning of the test and not disturbed afterward, lost by evaporation from its exposed surface only 28 pounds of water during the same

Fig. 1. Movement of moisture upward and downward from soil initially containing 22 per cent moisture to soil containing 14.5 per cent moisture. Column started September 2, 1922, and sampled January 8, 1923. Places of sampling and amounts of moisture found are shown by circular points along the curve

Fig. 2. Soil tanks used to determine losses of moisture by evaporation directly from soil surfaces. Further protection from temperature changes was later given by board sheathings cut to fit around the tanks

*Abstract of paper presented at the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, California, June, 1926. The paper in full will be published in the 1926 A.S.A.E. Transactions.

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period that the prune tree consumed its 1250 pounds. In another test a tank containing growing morning-glories, rather small plants, consumed in 23 days more than twice as much water as was evaporated from the bare, uncultivated surface of the same kind of soil in a similar tank in a period of over four years.

TABLE I. Average Losses of Moisture by Evaporation in Pounds per Square Foot from the Surfaces of Bare Clay Loam Soil in Tanks. Water Applied to the Soil on August 17, 1921

Treatment of soil	August 25	August 27	August 29	September 10	September 16	September 24	October 8	November 1	November 4
Undisturbed except to pull weeds	4.6	5.0	5.4	6.8	7.4	7.8	8.4	9.3	9.4
Cultivated weekly to depth of 6 inches	4.5	5.0	5.4	7.0	7.2	7.8	8.4	9.4	9.8
Cultivated weekly to depth of 8 inches	4.8	5.0	5.4	6.6	7.2	7.6	8.0	9.3	9.5
Cultivated weekly to depth of 10 inches	4.3	4.9	5.0	6.0	6.6	7.0	7.3	8.4	8.7

TABLE II. Summary of Soil-Moisture Contents in Three-Foot Depths, in Acre-Inches per Acre, in the Cultivated and Uncultivated Plots at Davis. Irrigated August 2, 1921

Depth of soil samples—feet		Aug. 3	Aug. 5	Aug. 8	Aug. 26	Sept. 23
0-3	Cultivated	11.09	9.83	9.50	8.56	8.46
	Uncultivated	11.94	10.44	9.88	9.13	8.33
3-6	Cultivated	8.94	8.38	9.36	8.99	8.52
	Uncultivated	9.59	9.08	8.85	9.03	8.70
0-6	Cultivated	20.03	18.21	18.86	17.55	16.98
	Uncultivated	21.53	19.52	18.73	18.16	17.12

TABLE III. Summary of the Soil-Moisture Contents in Three-Foot Depths, in Acre-Inches per Acre in the Cultivated and Uncultivated Plots at Whittier, 1921. Irrigated July 15, 1921

Depth of soil samples—feet		July 21	Aug. 4	Aug. 18	Sept. 3	Sept 30
0-3	Cultivated	9.59	8.98	8.55	9.09	8.82
	Uncultivated	9.98	8.71	8.71	9.09	8.60
3-6	Cultivated	8.49	8.21	8.21	8.38	8.32
	Uncultivated	7.93	7.88	7.88	7.99	8.05
0-6	Cultivated	18.08	16.76	16.76	17.47	17.14
	Uncultivated	17.91	16.59	16.59	17.08	16.65

TABLE IV. Summary of Moisture Contents in Four-Inch Depths of Soil, in Percentages, in Samples Taken Approximately Two Months After Irrigation

Location of plots	Treatment	Depth of soil sampled, in inches: 0 to 4	4 to 8	8 to 12	12 to 16	16 to 20
Davis	Cultivated	6.6	15.7	20.1	19.1	18.6
	Uncultivated	8.6	15.5	19.0	19.0	19.4
Mountain View	Cultivated	4.0	9.5	10.2	10.3	10.7
	Uncultivated	3.9	9.1	10.4	11.0	10.9
Delhi	Cultivated	1.3	3.9	4.1	4.1	4.2
	Uncultivated	1.5	3.1	3.3	3.7	4.1
Whittier	Cultivated	4.1	11.5	15.1	16.2	15.9
	Uncultivated	4.1	11.0	16.2	17.3	16.5

TABLE V. Relation of the Amount of Water Used to Leaf Area and to Length Growth

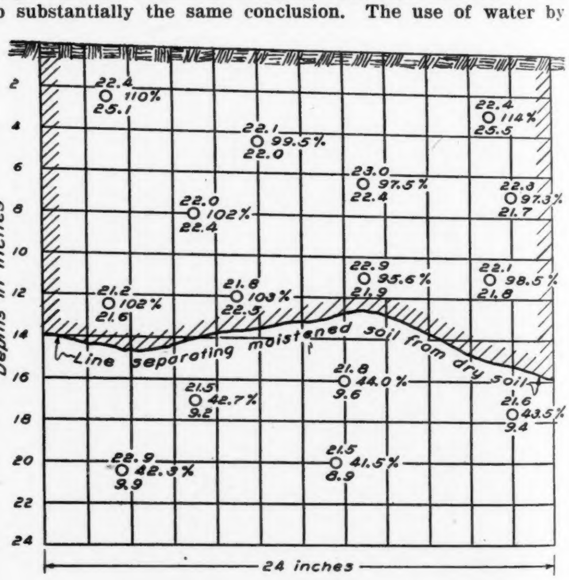
No. of tree	Length growth, inches	No. of leaves	Leaf area, sq. in.	Water used Mar. 1 to Sept. 25, lbs. per tree	Ratio of water use to leaf area, or loss per sq. in. of leaf area	Ratio of length growth to water loss or inches of growth per lb. of water used
5	348.0	394	2098	499	0.237	0.698
12	214.0	239	1244	316	0.254	0.678
20	697.5	828	4305	1020	0.237	0.683
21	351.0	398	2070	508	0.245	0.690

Tree No. 5. Soil kept above 16 per cent until middle of August, then alternately allowed to fall to approximately the wilting coefficient and irrigated.
Tree No. 12. Soil kept water-logged.
Tree No. 20. Soil maintained above 16 per cent.
Tree No. 21. Soil moisture fluctuated between maximum field capacity and wilting coefficient.
NOTE: Maximum field capacity or moisture equivalent approximately 22 per cent.
The coefficient of correlation between water loss and leaf area for all the trees, of which those given in Table I are a part, is 0.97 ± 0.11. The coefficient between water loss and length growth is 0.995 ± 0.002.

As a result of the findings above mentioned it is believed that many, perhaps most, of the conclusions drawn from studies concerning the water relations of plants grown under supposedly constant soil-moisture conditions are erroneous. In the light of the findings herein reported the author believes that most work of this nature is not free from the doubt that the uniform percentage of soil moisture assumed by the investigators actually was maintained. Supporting this doubt is the fact that numbers of trials by various associates of the author to establish a moisture content less than the maximum field capacity uniformly throughout a soil mass, regardless of whether the water was applied from above, from below, or by specially arranged perforated pipe irrigators, invariably have met with failure, and it is the opinion of the author that relatively low moisture contents are impossible of uniform maintenance in large masses of soil either in containers or in the field.

The phenomena which occur when water is applied to dry soil are shown in Fig. 3. At least with the loam soil used in these experiments, of which Fig. 3 is typical, the application of a definite amount of water results in the wetting of the soil to a definite depth, depending on the water-holding capacity of the soil and its initial water content, and that the soil throughout the depth wetted is raised to a moisture content closely approximating the moisture equivalent. There may be subsequent downward movement of moisture which continues for a long time and which would result ultimately in an increase in moisture with increase in depth. But observations of wetted areas of soil similar to that shown in Fig. 3 for periods of more than two months, with the soil covered with canvas to prevent evaporation and the addition of moisture from rainfall, resulted in no significant change in the soil-moisture content, and there is every reason to believe that in cropped soils the abstraction of moisture by plants always would be sufficiently rapid to intercept any downward movement of moisture.

Observations extending over a number of years in deciduous orchards and experimental orchard plots indicate that the soil-moisture supply may fluctuate between wide limits without affecting measurably the growth of the tree or the yield and quality of its fruit. Studies of trees grown in large containers under more rigidly controlled conditions lead to substantially the same conclusion. The use of water by



O = Point from which soil samples were taken.

Fig. 3. Distribution of moisture in a loam soil following a rainfall of 2.15 inches. The numbers above sampling points indicate the moisture equivalent as determined by the centrifuge method; those below, the actual moisture content of sample from the field. The percentages are the ratio of moisture content to moisture equivalent

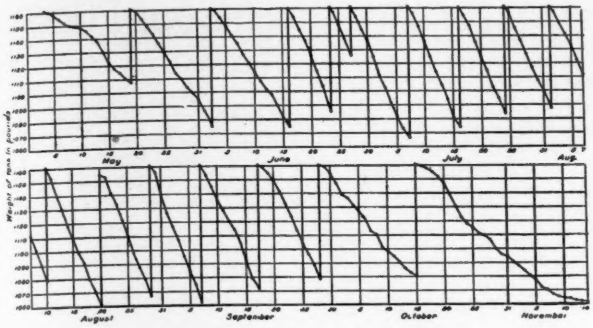


Fig. 4. Use of water by a prune tree during the season of 1922. With the soil at 22 per cent moisture the tank weighed 1161 pounds; at the wilting coefficient, 11.9 per cent, it weighed 1074 pounds

some of the young French prune trees grown under conditions of fluctuating soil moisture is given in Table V. The trees were not affected by differences in soil moisture content until it is reduced to a percentage corresponding to the calculated wilting coefficient, at which point the trees wilted and did not revive until water was applied to the soil. This wilting at a definite moisture percentage has been observed at different times of the year and in different localities.

Further evidence along this line is given by Fig. 4, derived from data obtained from a tree automatically balanced. It will be noted that the slope of the graph indicates the rate of use of water by the plant, and that the rate of water consumption is no more rapid at high than at low soil moisture content.

In view of the findings by a number of investigators that plants do not absorb solutes in the same proportion as they exist in the soil solution; that water and ash constituents are absorbed at different rates; that acceleration of the tranpiration stream does not accelerate the entrance of solutes; and the weight of evidence to the effect that the force with which water is held by a soil does not increase rapidly until the moisture content is reduced below the wilting coefficient, there appears to be no reason why optimum moisture conditions for growth should not vary from the maximum field capacity to the wilting coefficient. If it should be found that the results shown in these experiments are rather generally applicable to other crops and somewhat varying conditions, it would appear that many of our present beliefs with respect to the water relations of plants are subject to substantial revision.

Automatic Sprinkler Protection for Farm Homes

By Walter B. Jones

AMONG the sales arguments advanced by the makers of farm home water systems is that of fire protection. But, very properly, no great emphasis is placed on this point, for the obvious reason that a farm home water supply plant cannot furnish water in a sufficient combination of volume and pressure to control a fire of any size. To be of any practical effectiveness, the water from such a system must be applied when the fire is very small, shortly after ignition takes place.

It might be argued that if the quenching capacity of farm water systems is so small we might as well ignore them entirely and rely on hand extinguishers of the soda-acid or carbon-tetrachloride type, or even the good old-fashioned "bucket brigade," which, with a pair of robust farmers at the pump handle, usually will produce a greater volume of water than the typical water system. It may also be contended with some point that the pumping capacity, reservoir capacity, or both, according to the type of system employed, might well be increased over what is required for ordinary domestic uses for the express purpose of providing an added measure of fire protection. However, the extent to which this is economically feasible and otherwise desirable is limited, although a moderate amount of such increase in capacity might well be considered as a coordinated part of the plan herein proposed.

With the exception of fire originating from violent lightning strokes, explosion of gasoline stoves, etc., which can pretty well be prevented, disastrous farm fires occur chiefly when the family is asleep or away from home and, therefore, unable to work the portable extinguisher or organize the bucket brigade at the inception of the fire. This brings us to the nubbin of the whole matter, namely, that to make effective the protection of the farm home with its limited water supply, such protection must be automatic in order that is may come into action directly after a fire starts.

The obvious solution is the automatic sprinkler system, but, so far as is known to the writer, no engineering studies have been conducted to develop the maximum protective capacity from a limited water supply, to determine the minimum water requirements for incipient fires in the materials and under the conditions to be found in farm homes, nor to devise the most efficient construction and grouping of sprinkler heads to meet these conditions. The need for such study and development cropped out in discussion at one of the annual meetings of the American Society of Agricultural Engineers several years ago, but apparently nothing has been done about it.

Although the sprinkler protection of industrial and other city risks has been developed to a high degree, that development offers little in the solution of the present problem. The city sprinkler installation takes for granted an almost unlimited supply of water, as a glance at the four and six-inch piping used implies. That this seemingly extravagant use of water and piping is not entirely unjustified is shown by the fact that sprinkler systems originally were devised for risks involving highly inflammable and stubbornly burning materials, as in paint and varnish factories, and places where celluloid is handled in quantities. To meet these extreme conditions there was demanded a sprinkling capacity vastly greater than that which would be necessary for a farm home, where the worst problems are a gallon of kerosene in the tank of an oil stove in the kitchen, and a pile of kindling in the basement.

Not only is there a wholly new engineering problem, but the entire ground must be fought over anew from the insurance standpoint. The history of underwriter regulation is that the codes become ever more stringent and costly in their observance, in order to give full protection under the most extreme conditions ever encountered, regardless of how ludicrous some of the stipulations are for less hazardous situations, and of the unnecessary financial hardships imposed by their observance. It is absurd that a farmer, in order to qualify for a premium reduction on his milk house, must equip it according to the cut-and-dried rule worked out to fit a film factory.

If for no other reason than that no other engineering body of competent jurisdiction seems likely to undertake it, this is a job primarily for agricultural engineers. In addition to the farm water supply industry and the farm structures engineers, there should be represented in such a project engineering talent from the automatic sprinkler industry and experts in farm fire hazards from the fire underwriters. In all probability the rural electrification people also should be represented because farm water supply systems of the future promise to be chiefly electrically driven, and to insure that in the project due attention will be given to wiring and motor installations which may be depended on to function in spite of fire on the premises.

It seems proper, therefore, to suggest such a program as an activity for the A.S.A.E. Farm Structures Division, augmented by members from other divisions and from engineers and experts outisde the Society as the exigencies of the task seem to warrant.

Farm Structures Adapted to All-Steel Construction

By J. D. Parsons[1]

WITHOUT doubt, one of the surest ways of reducing the farm fire loss would be to use noncombustible material for all farm buildings. Probably no one noncombustible material can best serve in the construction of all types of farm buildings. If the material is attractive enough to be used for a residence it would probably be too expensive for a machine shed or other outbuildings. If it is ideal for a machine shed it may not be suitable for a dairy barn where a large amount of moisture is present or for an individual hog house that must be moved frequently.

The varying requirements of material for use in different types of farm buildings and the qualifications of various kinds of noncombustible building material offer an interesting opportunity for service on the part of the agricultural engineer.

All-steel grain bins became popular during the years 1910 to 1914 because of their noncombustible, weather-proof and rodent-proof features. Steel bins, when made of good grade material in proper gauges, are extremely durable and when empty may be moved on their sled platform foundations. This permits the addition of farm buildings and rearrangement of feed lots without sacrificing convenience.

The all-steel farm building is coming into use as its possibilities and limitations are better understood. The popular use of sheet steel as a farm building material has been delayed because of the early use of corrugated iron sheets over a wood frame. All too often this wood frame was poorly constructed, and the sheets nailed to this make-shift frame, therefore, gave trouble by working loose, nails loosening in the wood or sheets being torn from insufficient nailing. This gave the modern sheet steel building a big handicap

The present sheet steel building has a structural steel frame to which galvanized sheets are secured. Various manufacturers differ in their method of constructing the frame, using different methods of forming the sheets and of fastening them to the steel frame.

Recent tests by the U. S. Bureau of Standards, at the request of and in conjunction with the Sheet Steel Trade Extension Committee, on an all-steel two-stall garage show the effectiveness of a sheet steel building in confining a fire and preventing its spread to adjacent buildings. A full report of these tests may be obtained from the Sheet Steel Trade Extension Committee, or reference may be made to the July, 1926, "Quarterly Report of the National Fire Protection Association," pages 60 to 63.

Many progressive manufacturers are now in position to furnish buildings of this type for use as hay barns, hay sheds, machine sheds, garages, hog houses, brooder and chicken houses. These buildings usually are made in sectional forms with units small enough to be handled conveniently and can be put up without the aid of sheet metal workers if erection instructions are carefully followed.

The all-steel grain bin shown in Fig. 1 is thirteen years old and the owner says it is as good today as the day it was purchased. Such bins are rat-proof, noncombustible, and lightning-proof when properly grounded. Steel buildings make ideal warehouses, as they can be economically enlarged, are noncombustible, rodent-proof and may be dismantled, moved and erected again with practically 100 per cent salvage. A warehouse similar to the one shown in Fig. 2 is being used by the Farmers' Cooperative Association of Seminole, Oklahoma, as a state bonded warehouse for storing cotton.

The all-steel garage is moderate in price and will effectively protect a truck, tractor or car from the weather and at the same time protect other buildings from the danger of fire due to this type of equipment. In Fig. 3 is shown an all-steel brooder house which provides protection from fires due to brooder stoves. The house is provided with ample ventilator space and can be supplied with as many windows as desired.

[1]Agricultural engineer, Butler Manufacturing Company. Mem. A.S.A.E.

Fig. 1. A type of steel grain bin which is portable, yet durable

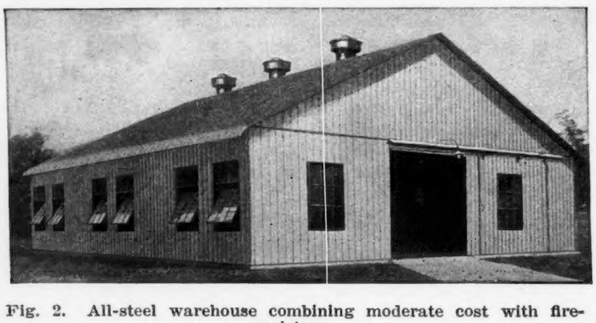


Fig. 2. All-steel warehouse combining moderate cost with fire-resistance

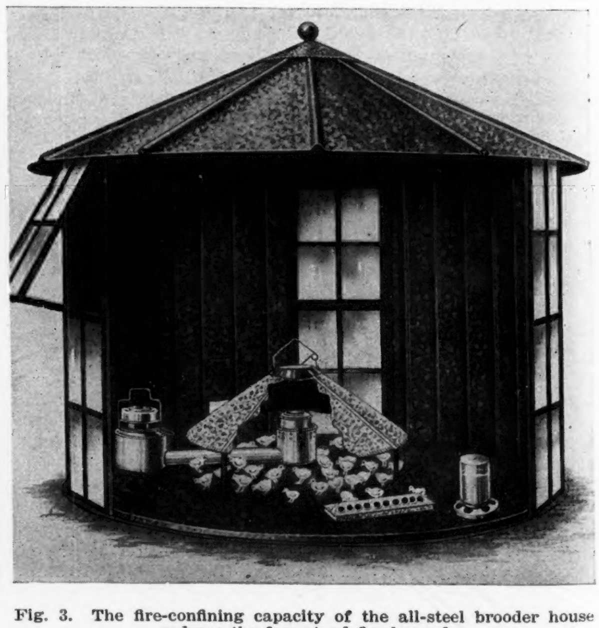


Fig. 3. The fire-confining capacity of the all-steel brooder house reduces the farmstead fire hazard

Observations on the Design of Farm Buidings

By R. A. V. Nicholson[1]

FARM buildings have, until recently, received very little attention from the architectural profession. Their development from a scientific agricultural point of view is also fairly recent, but this aspect is further advanced than the architectural one.

There are, of course, old farm buildings which possess considerable architectural merit, but the present day designers, while improving the ventilation, lighting and floor arrangements, have discarded most of the features which made the older buildings so effective in appearance. That these features are not incompatible with the best agricultural engineering practice has been proved in some instances but, in the majority of cases, the "practical" has been the only aspect considered. As a matter of fact, a proper architectural point of view is also a practical one. It is not, in any sense, opposed to engineering principles; good architectural design, whatever the subject, is simply the grouping and adjustment to each other of the various elements required in such a way that the whole scheme, rather than any one feature, may be as perfect as possible.

Farm buildings have not attracted the attention and study of the average practising architect, possibly because few farmers could afford the professional fees involved. The growth of large country estates has been responsible for first bringing the architect in touch with the subject, where the architect has simply adapted certain dimensions of stalls, mangers, etc., to his already designed scheme, the result, while pleasing in appearance, has not been a proper agricultural solution of the problem. On the other hand, farm buildings designed by engineers or agriculturists show intelligent study of the requirements as to ventilation, lighting and contruction, but quite ignore the question of appearance. The few architects, however, who have studied the question from all points of view, have produced buildings which, while fully as useful from a practical standpoint, also represent a considerable advance in architectural treatment.

In the first place all rigid ideas of symmetry must be discarded in the design as the requirements are so many and so varied that absolute freedom of plan must be allowed. The various buildings on a farm cannot be made to harmonize, according to the accepted traditions of architectural design, without seriously affecting their practical requirements. The proportions of a cattle barn, for example, are largely predetermined and the designer has little latitude in the length, breadth and height of the various portions of the structure; these bear a certain relationship to each other governed by considerations not within the control of the designer.

The three main considerations in the design of farm buildings (or in any building) are plan or arrangement, construction and appearance; these are all inseparably linked together in good design and must be considered together. A good plan involves the location of the various units with reference to each other in such a manner as to afford proper functioning with the least lost motion and waste of space, operation with the minimum of labor, ease of access and communication and, in some cases, allowance for expansion. Such a plan requires the cooperation of those thoroughly familiar with the operation, maintenance and functioning of the various units on a farm and those familiar with the grouping of such units in a well-balanced plan involving the features before mentioned. Such cooperation intelligently considered will result in a plan whose exterior and interior may be both sound in principle and pleasing in appearance. No set rules can be laid down. The result may, and often will, be a rambling type of plan in which each unit is treated according to its special requirements. Irregularities of site should be taken advantage of as there are great architectural possibilities with buildings on different levels. Planting, frequently neglected, will help to soften otherwise hard outlines. Ornament should be used sparingly and should be large in scale.

The development of the gambrel roof with the so-called "plank frame truss" has increased the storage capacity of barns and has provided a mow space clear of all obstructions. This roof, however, requires careful treatment of proportions in order to secure a satisfactory outline. The common tendency is to make the barn too high, both for appearance and for the storage capacity required. While the gambrel roof is almost universal in new barns, the gable roof still has practical possibilities worthy of study. The plank truss, a form of scissors, may also be used here with some modifications from that used in the gambrel type. This truss brings the support required for the ridge-pole to the side of the structure and then directly to the ground. This roof, while perhaps difficult to adapt to the cattle barn with loft and stable below, would be eminently suitable for the hay storage barn.

One of the most difficult problems of architectural treatment is the silo. If slightly separated from the barn, it might be treated as a tower and many interesting and charming examples of this may be found among the old farmsteads of France. It is, however, difficult to harmonize a tower, reminiscent of mediaevalism, with a modern "hip-roof" barn.

The interior of the barn is primarily a matter of cleanliness; the walls should be of a material that is durable and

[1]Architect, Dominion Experimental Farms Branch Dominion Department of Agriculture (Canada). Member, Royal Architectural Institute of Canada. Mem. A.S.A.E.

Due attention to artistic values in farm building architecture will contribute largely to the satisfaction of living and laboring on the farm, and to the respect in which the farm business and farm people are held. Warm cooperation between the farm structures engineer and the specialist in pure architecture can add something of beauty and much of good taste to the farmstead, and this without sacrifice of utilitarian efficiency or undue inflation of investment. Architecturally the silo is rather difficult to reconcile with the engineering desiderata of the buildings with which it is associated. The design here emphasizes the lines of the gable roof in an effort to harmonize the barn and silo in a structure integrated for operating efficiency

sanitary and easily kept clean. A Keene's cement dado, with plaster above, is probably the most sanitary finish, but wood may also be used satisfactorily. Pure white is too easily soiled, whereas dark colours, while they will not show the dirt, will darken the stable unnecessarily. Neutral colours will appear clean, even if slightly soiled and yet will show sufficient dirt to necessitate fairly frequent cleaning. Moldings on doors, windows, etc., should be entirely dispensed with as well as all interior corners as no projections must be allowed which will permit the lodgement of dust.

In conclusion, planning has been described as consisting of two things—the material satisfaction of the program in a mechanical way and then the introduction of the artistic or expressive element. I am convinced that these two elements may be combined in the design of farm buildings, but careful study and knowledge of both are necessary for the production of really satisfactory solutions.

How Many Boys to Outpull a Tractor?

By E. G. McKibben[1]

THE tug meter (Fig. 1) was designed and built for the purpose of indicating to the spectators the pull being developed, and recording the maximum pull exerted, during the annual tractor-boy tug-of-war contest of the California Boys' Agricultural Club camp at Davis. However, there is no reason why the idea should not be of equal value for any form of traction demonstration where keeping the audience constantly informed is more important than scientific accuracy.

In the construction of the tug meter a traction dynamometer ("Tractometer") of 3000-pound capacity was used as a nucleus. (See "a," Fig. 1.) This dynamometer was mounted in a system of levers (b) which could be so adjusted that the dynamometer would be subjected to either the entire pull, or one-half, or one-third of the entire pull, thus multiplying the dynamometer dial reading by 1, 2, or 3. A frame (c) carrying a 36-inch scale (d) and a 60-inch pointer (e) was attached to the dynamometer frame. By the use of the proper levers the pointer (e) was also connected to the moving unit of the dynamometer. By use of two large trees and a chain hoist the large scale (d) was calibrated to agree with the small dial of the dynamometer (a). In order to give a direct reading on the large scale for each adjustment of levers (b), three scales, reading from 0 to 3000, 0 to 6000, and 0 to 9000, respectively, were made. A simple recording device (f), consisting of a piece of ⅛-inch pipe 4 inches long with one end capped, a small compression coil spring, a short lead pencil and a piece of ⅜-inch fiber obard drilled and threaded to receive the pipe in three positions, was attached to the pointer (e). Thus a record (g) of the maximum pull developed was obtained. The completed instrument was mounted on a John Deere orchard cultivator frame.

The tug meter was used this fall in the tractor-boy tug-of-war and added greatly to the interest in and success of the contest. This contest is the last event on the program of the Boys' Agricultural Club camp, which is held at Davis each October and is arranged by the Division of Agricultural Engineering in cooperation with the Division of Agricultural Extension of the University of California. It consists of a 45-second tug between a Caterpillar "30" tractor and a selected team of boys from each of the battalions. The weights of the individual members of the teams were obtained by use of a Toledo platform scale. The time required averaged only about 1.5 second per boy.

From the data secured the results given in the accompanying table were calculated. Although the figures given from the total pull were maximum, they were approximately equalled several times during each tug. Also, the advantage of a large power unit over a group of smaller power units should be noted. The tractor pulled a higher per cent of its weight than any team of boys did, while any one of the boys, if he had been pulling by himself, probably could have pulled a higher per cent of his weight than the tractor did.

The contest was won by group No. 3 which developed the highest total pull and also the highest pull per pound of boy. This group pulled the tractor to practically a standstill, the tractor being able to gain only a few feet during the 45 seconds of the tug.

TABLE SHOWING TUG-OF-WAR RESULTS

Group	No. of boys*	Weight (Pounds) Maximum	Minimum	Median	Mode	Mean	Total	Pull Developed (Pounds) Total	Per boy	Per lb. of boy	Per cent of weight
1	76	156	23	112	85	102	7787	5100	67	0.66	66
2	100	162	64	114	85	108	10752	6600	66	0.61	61
3	101	189	67	128	120	112	11310	7850	78	0.69	69
Total							29849	19550	71	0.66	66
Tractor							9175	7850			86

*The age of the boys ranged from 10 to 18 years.

[1]Junior Agricultural Engineer, University of California. Mem. A.S.A.E.

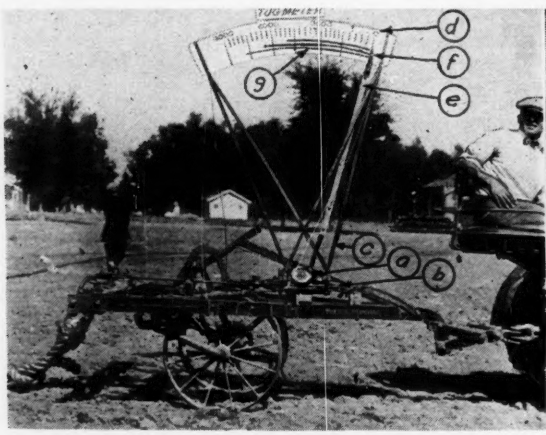


Fig. 1. (Left) A general view of the tug meter designed for the purpose of recording the pull in a tractor-boy tug-of-war. Fig. 2. (Above) An "action" view of the tug-of-war

The Combine in North Dakota*

By R. C. Miller[1]

THE investigation of the combine in North Dakota was along two lines. One was a personal investigation, co-operating with C. D. Kinsman of the U. S. Department of Agriculture; and the other was a questionnaire investigation made in November.

Twenty-five combines harvested and threshed various crops including wheat, oats, barley, rye, buckwheat, sweet clover, flax, speltz, and alfalfa—one or more of them—in practically every section of North Dakota in 1926, the second season for combines in the state. In 1925 three combines were operated in North Dakota. The drier parts of the state naturally being the most suitable for combines resulted in about fifteen more combines being used in the northwestern part of the state this year. Others were scattered over the rest of the state: three more in the southwest, three more in the northern part, and one more in the Red River valley near Fargo.

On August 16 I met Mr. Kinsman at Williston; combine harvesting was at its height that week, and we saw eleven combines and combine owners. The first day we observed four combines in operation north and west of Williston. In this territory crops were good and we could see what the combine could do in good grain. We interviewed grain elevator managers as to how combine grain was marketed. They all declared against the practicability of the combine because of moisture especially. We found all owners enthusiastic. They were all storing their grain on the farm.

The second day we went southeast of Wiliston in a dry section this year where crops were short and yields were small. Much of the grain was not fit to cut with binders. Many fields were cut with mowers and the grain raked into windrows. Three to seven bushels were the common yields for wheat. The combine was popular because it showed up well in such a short crop where wastage is great by other methods. Most nonowners of combines interviewed declared it would not be a successful machine in wet years because of uneven ripening of grain. Again all elevator men declared the combines were not practical. Some were receiving grain from combines, but most of the combined grain here also was stored on the farm either in granaries or open bins. Some farmers were combining even after it had rained considerably.

One interesting incident occurred where we interviewed a neighbor of a combine owner. He did not think it a practical machine but had hired this combine at $3.00 per acre to combine his wheat crop which he had judged would not yield three bushels per acre if cut with the binder. In fact, he had started to harvest it with a binder but, on obtaining only three bundle carriers full of bundles in a half mile, had stopped harvesting. The combine obtained him a yield of six bushel per acre, a gain of three bushels, or 100 per cent. Most combine owners declared the combine saved from one to three bushels more wheat per acre.

The greatest disadvantage of the combine was Russian thistle. The dry growing season made the thistle thrive so it often was as tall as the short wheat, some thistle being cut and threshed with the wheat. The thistle, being moist, raised the moisture content of the grain above the safe limit even if the wheat was dry and ripe. Practically all the samples that had over 14 per cent moisture had weeds as the reason. Therefore, where it appeared as though this were an ideal combine year, there proved to be some drawbacks. However, it was costly and wasteful to harvest the grain by binder or header. The weeds and an unseasonable wet spell made combining a problem. Later reports from these combine owners indicate that they had no losses after the grain was combined.

*A contribution to the combine symposium presented at the meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1926.

[1]Assistant Professor of Agricultural Engineering, North Dakota Agricultural College. Mem. A.S.A.E.

A heavy rain the afternoon and night of August 17 and part of August 18 stopped all combining, so on that day we called on elevator dealers and implement dealers on our way east and north. At Starkweather we found a Mr. Davis had made several rounds of a wheat field for trial. The wheat was damp, about 17 per cent moisture, but was keeping in good condition in a bin. Harvest was delayed about three weeks in this northern section by rains. On August 18 we saw only one combine, and that was at Arvilla, near Grand Forks, in the eastern part of the state. This combine was operating in the rain. Binders were not in the field. This combine was working in oats with a heavy stand of sow thistle. Twenty-five hundred bushels of oats had been combined with only the help of several boys and an old man. The oats were stored on a large barn floor.

All the samples taken the first day had less than 15 per cent moisture. The grain was free from weeds in this area. On the second day, weeds and rain both were factors in bringing up the moisture content, which ranged from 13.8 to 17.4 per cent.

Among the combines visited were two 9-foot Case, one 12-foot Case, five 16-foot Case, and four 10-foot McCormick-Deering. All were drawn by tractors of 15 to 20 drawbar horsepower. In one case where the ground was hilly and sandy a Fordson helped a 15-30 tractor. Four of the combines were driven with power take-offs, and appeared to be doing good work. Several machines had straw spreaders. Most of the machines had bins.

The only changes in machines wanted by owners usually was for larger machines, where they had the smaller outfits. However, one owner of a small outfit prefers it to the larger and expects to buy another. His argument in favor of the small outfit is that the saving in cost of the machine will go a long way to buy a second tractor, and he wants the extra tractor power available for other field work.

Nearly all owners felt that some economical drying method would solve practically all their difficulties.

The general impression from this survey was that the owners like their combines, the saving in labor cost being sufficient to over-balance any losses or cost of drying. The elevator men are agreed unanimously that the combine is not practical in North Dakota, wet seasons, uneven ripening, losses due to wind, hail, rain, insects and spoilage in bins being the reasons given.

About November 10 a questionnaire was sent to the various combine owners in the state and near the Montana state line. Twenty-five questionnaires were sent out and to date thirteen adequate replies have been received. The twenty questions deal with problems, solutions, losses, recommendations, experiences, and data in regard to each crop harvested. Some of the more pertinent problems are: Some way to install cheap driers in granary and bins in field; check by the college to make comparisons with threshing machines as to moisture; shock loader for combining bundle grain; means of proper ventilation for grain bins to keep grain from heating and to eliminate shoveling and moving from one bin to another. Damp grain and artificial drying were the vital problems.

Practically no losses were reported that would not have occurred with the binder method. Even the wet oats brought a good price, considering it was foul with thistle and at least would have graded low.

The tabulated replies relative to harvesting different crops showed 7560 acres of wheat, 1480 acres of flax, 1070 acres of rye, 415 acres of oats, 230 acres of barley, 20 acres of speltz, and 60 acres of alfalfa, a total of 10,835 acres harvested by thirteen combines, or an average of 833 acres each.

The tabulation shows that yields as a rule were low, that two to three men did the harvesting, threshing and hauling of grain to the granary, that the cost of operating was low, varying from 4¼ cents to 10 cents a bushel for wheat, in most cases being about 7 cents.

All the owners replying state that the combine is a good investment. Some make statements that it more than pays for itself in two years. One man states he half paid for his combine this year with custom combining. Of special interest is the report from the combine farthest northeast in the state, parts of which follow:

"We dried our grain by spreading it thin for one to two weeks; some of the oats were spread thin for a month, and were placed in bins perfectly cool, only to heat even then. We feel that weed leaves and weed buds caused us more trouble by far than the ordinary operator would encounter. We took up a dirty farm here a year ago, possibly a weedier one could not have been found in the country. If the grain had been clean, do not believe we would have had much trouble with the method we practiced, but our conclusion is that some sort of a drier is essential.

"We had excellent results with 90 acres of flax, cutting it late after the pigeon grass and other weeds had frosted. (That is the experience all through that territory. Every one reported it was the ideal method of combining flax—Author.) We cut this flax in four short days at a total cost of $36, and were stopped only twice during this run, having probably ten minutes trouble in all.

"We could not harvest buckwheat at all with the combine as it is too green and full of sap until frosted, and then it goes down like a tomato. The flax was marketable at cutting time with no discount, but it would not have been had not the frost put the weeds down. Our limited experience would show, however, that the flax will shatter but little, and with late flax the machine does good work.

"We found a new use for our combine which seems almost as important to us (with a farm too dirty for ideal combine purposes) as is the cutting and threshing of standing grain. For bundle threshing we removed the reel and cutting platform and on the same iron supports we placed a wood platform similar in size to a hay rack but carried about two feet from the ground. The harvester (or rather thresher now) was driven up a shock row and some 15 or 20 shocks pitched on the platform by two men; then we would stop and thresh it. Two men and a boy to drive the tractor will thresh two-thirds as much as the ordinary thresher of similar capacity. (This is exclusive of teams to take the threshed grain away). Teams and racks are entirely out of the picture. If a shock loader could be added to throw the shocks on the platform, it would not be necessary to stop, and two men, one on the tractor and the other pitching in to the feeder, would thresh just as much as the ordinary threshing crew."

Very few troubles in operating combines were reported. The chief ones mentioned were need for more power to pull the combine in loose and hilly ground, and some trouble with feeding heavy grain into the combine.

Wheat and flax, of course, are the big crops harvested with the combine in North Dakota, and it seemed to be very successful in practically every part of the state.

The study to date gives me the following impressions of the combine in North Dakota: It does a most excellent job of harvesting and threshing. No unthreshed heads of grain were found. Only in rare instances, for example in climbing ridges, was any grain found lost due to poor separation.

It will, if successful, eliminate the North Dakota twine bill, the transient labor bill, reduce wagon and rack investments, reduce the number of horses kept for threshing purposes, increase work for tractors, save grain or increase effective yields, make possible early fall plowing and thus eradicate weeds and increase yields. Diversification would be encouraged because the farmer would have more time to take care of stock. It should easily reduce the cost of harvesting at least $2.00 per acre. This with our average 10-bushel per acre yield would make a 20 cent per bushel more profit.

The combine must, however, overcome the problem of wet grain and weeds. Saving of straw is another problem. Losses due to hail, wind, rains, insects, vermin and shattering must be kept low. Whether these losses are excessive is an investigational problem.

This matter of wind was one of the objections raised by people who did not own combines. And when we asked the farmers how often they lost their crops due to wind they said about once in every ten years, and then it usually caught them with binders as well as combines. I think a thorough survey will show that most of the hail storms catch them with binders as well as with a combine. The hail comes usually in July.

There is no doubt but that there is a big market for combines in North Dakota. No matter what is said unfavorably against them, the farmer appears to want them and will have them.

The Combine in Ohio*

By G. W. McCuen[1]

THE history of the combine in Ohio does not date back very far. Last year the first combines were used to harvest wheat and oats. Soy beans were harvested with a combine during the fall of 1925. When the probable use of combines was considered in Ohio I took the matter up with the farm crops department at our institution, and they were at once interested and decided it would be well to make some observations on their variety tests as to the possibility of finding certain varieties of wheat, oats, and barley which could be harvested successfully with a combine. Elaborate observations were made of these crops and one year's work is done which will be of value in determining the best variety for successful harvesting with a combine, especially to the farmers in Ohio who are considering the possible purchase of a combine in the near future.

Ohio is considered more or less of a humid state but rainfall data covering a period of ten years shows that at Concordia, Kansas, they had 7.93 inches of rainfall while in Ohio only 6.86 inches fell in the period during which a combine would be used. This leads us to believe that the rainfall factor will not enter largely into the consideration of the use of the combine in Ohio.

The first combine in Ohio was used on the farm of two brothers who were former students at Ohio State University. When the matter of demonstrating a combine on their farm was first considered with them, their father was much opposed to the use of such a new innovation on their farm. We promised him that if there was a loss of grain as a result of the use of the combine, we would reimburse them for such losses. Under this agreement the combine was demonstrated on their farm. Part of the field was harvested in the usual way and the remainder was harvested with the combine. From the observations and tests made on both methods we found that with the binder-thresher method of harvesting there was a net loss of 178 pounds of wheat per acre and with the combine method there was a loss of only 102 pounds of wheat per acre.

The saving of the losses in harvesting and the great saving in the labor of harvesting were the factors that influenced these boys to purchase the machine.

Another machine under our observation was in the northwestern part of the state. Both users are highly pleased with the results of the first year's work. The work the machines did with oats far surpassed all expectations under the very bad weather conditions of this fall.

The straw was gathered by using the old-fashioned buck rake or sweep rake and the labor charges were much less than where it was baled out of the stack. The farmers of Ohio are much interested in having the straw baled and stored in the barn. The majority of them prefer baled to loose straw for it is much more easily handled in the winter time and less storage space is required.

We anticipate a great deal of interest in the combine

*A contribution to the combine symposium presented at the meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1926.

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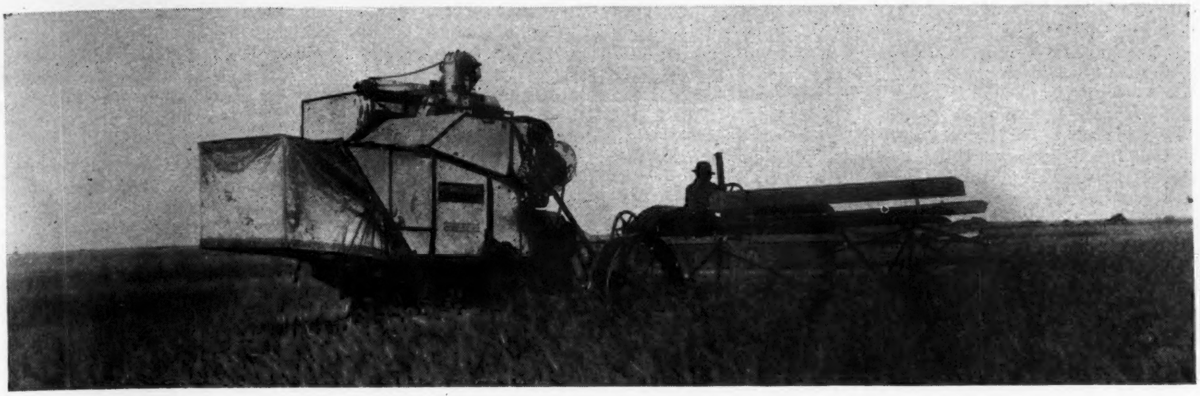

next year. Farmers in many sections of the state are considering the purchase of such equipment. The question of saving labor is the influencing factor in their consideration of the combine. Many have asked us as to the merits of the machine. Inasmuch as we do not have conclusive data relative to the possibilities of the combine, we have advised them to use their own judgment when considering purchases.

Combines were shown at the Ohio State Fair last fall, and from the prospects obtained from the different companies, we expect there will be at least thirty or forty combines sold in the state during the coming season.

The Combine in Pennsylvania and Delaware*

By R. U. Blasingame[1]

THE combine harvester-thresher strikes a new note in Pennsylvania agriculture, and although use is of too short duration and its numbers too few to justify any firmly held conclusions, nevertheless the experience of the owners of these few machines throws considerable light on the adaptability of the combine to the climatic conditions and farming methods prevailing in an agricultural area of considerable size and importance.

There are four combines in Pennsylvania and another at Georgetown, Delaware, which, both because it does considerable custom work in Pennsylvania and is not being otherwise reported on at this time, will be included in this discussion. Of the five machines three are driven by auxiliary engines and one by power take-off. The fifth was purchased after the 1926 harvest and affords no pertinent data.

The oldest combine in Pennsylvania is the one Ralph Brinser, of Elizabethtown, purchased in 1920. This machine enjoys distinction as one of the pioneer combines in the East having been bought at a time when even the manufacturers of these machines considered them impractical outside of the semi-arid areas of the West. Mr. Brinser's use of the combine carries additional interest because his farm happens to be located on a 300-acre island in the Susquehanna river. His annual use of the machine is approximately as follows: Wheat, 100 acres; oats, 70 acres; buckwheat, 40 acres; and small acreages of barley and rye. Mr. Brinser reports that he harvests all the grains mentioned with no loss of grain and with no trouble in taking care of the threshed grain. After five seasons' use he considers it unexcelled for harvesting any of these grains, mentioning particularly oats. He emphasizes both the saving in operating costs (he runs the outfit with two men) and the lower loss of grain.

Mr. Brinser has encountered a supposition that the weight of the combine would pack the soil to an objectionable degree, but he finds this objection unfounded in his own experience. He states that the combine does no more harm to the grass for which the grain has served as a nurse crop than is done by a tractor pulling a binder. In his opinion the combine is just as applicable to Pennsylvania as to any other state. He reports that the cost of combining is less than half that of employing binder and thresher, and believes that the combine can be used economically by any farmer having forty acres or more of grain.

The next oldest machine was bought by Harold B. Short, Georgetown, Delaware, in 1924. His experience has included wheat, soy beans and buckwheat, but not oats, although he believes that oats can be handled as well as the others. Mr. Short's machine has a twelve-foot cut and the capacity which he experiences is about three acres an hour in heavy grain and four acres an hour where the grain is medium to light. As these terms are relative it may be mentioned specifically that on one occasion he cut and threshed 38 acres of wheat, yielding 820 bushels, in 6 hours. Mr. Short operates on a bagging basis, and his crew consists of the bagging man, header, tender and tractor operator. For custom work his charge is $3.00 an acre.

As to damp grain, Mr. Short holds that the advantage is with the combine, as standing grain dries out much more quickly than bundles in the shock. Regarding small fields, which have been considered an objection to the combine in many territories, Mr. Short mentioned having worked in a three-acre field with just as good result as in a fifty-acre field. He considers that more grain is saved, and that in general it is in better condition when combined than when harvested by older harvesting methods.

The other two machines for which experience reports are available were not purchased until 1926, consequently only one season's work is included. The owner of one of them—the machine driven with power take-off—in discussing the matter of moisture during harvest and in the threshed grain says:

"I do not believe there has been a harvest season that has been more unfavorable than the past one, not only at the time of harvesting but several weeks after the actual storing of the grain. We stored our wheat on the barn floor in bags and found when we sold it in September that the wheat had dried out perfectly except here and there an occasional bag, probably not more than two per cent being a trifle mouldy. This we account for as due to the fact that at harvest time there were small spots throughout the field which ripened slower and later than the rest, a condition occurring this season on other farms as well as our own. I think that the damp bags were filled while cutting through the green spots and that in a normal season when grain ripens evenly there would be no trouble of that kind at all. Even with a little damp grain in some of the bags there would be, in a normal season, a little wind and sunshine at and after harvest, and I believe there would be no trouble

*A contribution to the combine symposium presented at the meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1926. Abridged.

[1]Professor of Farm Machinery, Pennsylvania State College. Mem. A.S.A.E.

in drying out the grain if allowed to stand in bags for several weeks."

This owner points out that the investment in his small combine is no greater than that in a good binder and thresher. He encountered no mechanical difficulties whatever and considers the machine worked out to what may be called commercial perfection. He did have to replace the platform canvas due to a peculiar condition arising from the unusual season. He had sown sweet clover in the grain, and due to the peculiar weather conditions the sweet clover grew as tall and in some cases taller than the grain, both oats and wheat, whereas ordinarily the grain would be enough taller to permit heading it without touching the sweet clover. This year the sweet clover was so juicy that it not only damaged the elevator canvas seriously, but added much moisture to the grain. In the oats the grain came through actually wet with the sweet clover juice and caused a little elevator trouble. In view of the fact that there was more sweet clover than oats going through the machine the performance of the combine was much better than could have been expected. There was some clogging of screens by the green sweet clover resulting in carrying over some grain.

The matter of straw saving is one of considerable importance in the Pennsylvania territory, and many farmers, including some of the combine owners themselves, think that this rules out the combine for farmers operating on a dairy or livestock basis. Others believe that alternative methods of handling and saving straw make this objection unfounded. One owner states: "We expect to use our side-delivery rake and hay loader and a set of slings."

Others refer to the straw bunching attachment as meeting the problem satisfactorily, but as the very few combines now in use are employed chiefly on grain farms where the straw is desired on the ground rather than for bedding, there is little or no actual experience with straw-saving methods. One farmer suggests the desirability of building combines with a baling attachment.

In conclusion, so far as may be inferred from the limited experience available, there appears no serious handicap of a fundamental nature to the use of the combine under Pennsylvania conditions. As elsewhere, the outstanding advantages are greatly reduced costs of harvesting and greater amount of grain saved. The indications are that combines will be used in increasing numbers, but to what extent they displace older methods of harvesting is at this time problematical.

Field Tests of the Combine in Indiana*

By R. H. Wileman[1]

PREVIOUS to the past summer only one combine was used in Indiana, and that was for soy beans during the fall of 1925. It was therefore a skeptical lot of farmers who greeted us when we began looking for wheat and oats on which to try the combine. After no less than six attempts had failed, we were able to get the promise of the manager of one of the Purdue farms to save ten acres of wheat and ten acres of oats, provided we would harvest twenty acres of soy beans for him.

The results reported were secured with a 10-foot, power-take-off-driven combine having a spike cylinder. The ten acres of wheat on which we used the combine was a portion of a 35-acre field, the rest of which was harvested by the ordinary binder-thresher method. Checks were made on both systems of handling to determine grain loss, time required, and all expenses calculated as nearly as possible.

From the ten-acre plot the combine threshed 19,010 pounds of wheat, or 31.7 bushels per acre. Part of the wheat was hauled directly to the elevator for fear it would not keep unless it was spread out, but it graded No. 1 and tested 11.2 per cent moisture. Upon getting this report the remainder was held on the farm and is now being guarded as seed. The only objection the elevator man had to this combined wheat was the large amount of segments of grasshoppers that had been threshed.

Due to the wet weather which followed, the shocked grain was not threshed until nearly three weeks later, giving a yield of 30.8 bushels per acre of wheat which graded No. 3 and tested 14 per cent moisture. However, it cannot be said that this difference will result as an average over a ten-year period as the weather was very unfavorable for handling grain from the shock.

The combined grain required 2.03 hours of man-labor and 2 hours of horse labor per acre from standing grain to the bin, while the binder-thresher method required 5.08 hours of man labor and 5.59 hours of horse labor per acre.

The loss of grain with the combine was 4.16 per cent as compared with 6.62 per cent with the binder-thresher method, giving a difference of 2.46 per cent of the total in favor of the combine. When reduced to dollars and cents the combine had a credit of 7.09 cents per bushel in its favor, the cost figures being 16.7 cents per bushel with the binder-thresher method against 9.61 cents per bushel for the combine. These costs are only relative, however; we estimated as closely as we could depreciation, interest, etc., on the combine. These figures, moreover, are the results of one test under one set of conditions and constitute only a progress report which may not be the average, but which we believe approximates the average costs of the two methods.

About ten acres of rye were handled with the combine, on which no records or checks were made. The machine worked satisfactorily except that where the rye was exceedingly tall some trouble was experienced in getting the straw through the throat onto the feeder chain because the length of the straw was greater than the width of the canvasses even when cut as high as possible.

Next came the oat crop, of which we harvested 10 acres. There was considerable question as to whether the oats would not shatter badly if allowed to get ripe enough for the combine. Very little shattering was experienced, however, and the oats were of such a quality that a premium has been offered for them.

Five soybean harvesting demonstrations were held in as many counties with the idea of showing the farmers what the combine would do and the possibilities of increasing the production of soy beans for seed by using the combine to harvest them. Much interest was shown in this project, the average attendance being 125 persons. The loss was found to be 6.4 per cent, which is much lower than we have been able to obtain by any other method. The rate of handling soy beans has been slower than with wheat or oats, as would be expected, and has required an average of 4.2 man-hours per acre. Part of that slowness was due to the weather conditions this fall. The ground was soft and we did not have enough power to keep the combine up to the proper speed and take it where it should go. We even had to resort to hooking on two tractors at times to get through the fields. However, this is much less time than is required by other methods. The greater efficiency of the combine in handling this crop together with the marked decrease in labor appealed very strongly to farmers and should do much to stimulate the growing of soy beans.

In adopting the combine it will be necessary for the farmer to be supplied with grain varieties which do not shatter readily and which have a stiff straw. Some of our present varieties conform fairly well to these desiderata, but no doubt can be improved upon.

From the experiences with the combine in Indiana, we believe that it is here to stay and that with some refinements and the ironing out of a few mechanical weaknesses, together with the development of a method of saving the straw economically, which has been the greatest objection with us, the combine will come to be the most practical method of handling grains.

*A contribution to the combine symposium presented at the meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1926.

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Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

Kinematics and Dynamics of the Wheel Type Farm Tractor*

V. Stability

By E. G. McKibben[1]

THE stability of a tractor is important for at least two very fundamental reasons, first, the danger to life and equipment in case the tractor becomes unstable and turns over backward, and, second, the varying ratio between the supporting soil reactions (R_3 and R_5 of Fig. 19) at the front and rear wheels. (The word "stability" as used in this article refers to stability against turning over about an axis parallel to the rear axle.)

The danger of overturning may be eliminated by the use of one or more of the following: Proper location of the center of gravity; proper location of the hitch points to the implement and the tractor; device to shut off the power when the tractor rises in front; careful operation. While the changes in the ratio of R_3 to R_5 can to a certain extent be minimized by the above, they could be eliminated only by the unattainable, ideal situation described later.

The following discussion is based on the moment equation developed in the preceding article. This equation was the result of the summation of all moments about an axis, parallel to the rear axle, through the point of intersection, C, of the resultants of the tractive soil reactions against the drive-wheels and the supporting soil reactions against the rear wheels. (Fig. 19.) Considering the situation shown in Fig. 19, this equation may be written,

$$P_1x_1 + \frac{Wa_hx_3}{g} + I_w\alpha_w + R_2d_7 + R_4d_8 + R_5d_9 + R_6d_{10} + F_1d_{15} = Wx_2 + \frac{Wa_vx_4}{g} + I_t\alpha_t \quad \text{.......... (22)}$$

Any change tending to increase any term on the right of Equation 22 will tend to increase the stability of the tractor. Any change tending to increase any term on the left of Equation 22 will tend to decrease the stability of the tractor.

If the motion of the center of the rear axle is parallel to a plane soil surface, a_v and α_t cannot exist until the tractor is unstable and R_5d_9 has become zero, therefore, for all other value of R_5d_9,

$$R_5d_9 = Wx_2 - (P_hx_1 + \frac{Wa_hx_3}{g} + I_w\alpha_w + R_2d_7 + R_4d_8 + R_6d_{10} + F_1d_{15}) \quad \text{.......... (23)}$$

It should be noted that, until the front end starts to rise, R_5d_9 is the dependent moment, the magnitude of which is a function of the moments on the right of Equation 23.

Therefore, if

$$Wx_2 < (P_hx_1 + \frac{Wa_hx_3}{g} + I_w\alpha_w + R_2d_7 + R_4d_8 + R_6d_{10} + F_1d_{15}) \quad \text{.......... (24)}$$

the moment R_5d_9 will have zero value and the front end of the tractor will start to rise. When the front end starts to rise $\frac{Wa_vx_4}{g}$ and $I_t\alpha_t$ will appear and tend to temporarily retard the rotation of the tractor. Since $\frac{Wa_hx_3}{g}$ and $I_w\alpha_w$ are temporary, $\frac{Wa_vx_4}{g}$ and $I_t\alpha_t$ may counteract $\frac{Wa_hx_3}{g}$ and $I_w\alpha_w$ or a temporary increase in P_hx_1 sufficiently to prevent overturning. However, $\frac{Wa_vx_4}{g}$ and $I_t\alpha_t$ cannot counteract a permanent increase in P_hx_1.

Ratio of x_2 to x_1, that is $\frac{(x_2)}{(x_1)}$. It is evident that, if any one of the terms to the right of Expression 24 becomes greater than Wx_2, the tractor will start to rise in front. Since the magnitudes of force F_1 and moment arms d_7, d_8, d_9, and d_{10} are usually quite small, and since a_h and α_w can be practically eliminated by careful handling of the clutch, the relationship between Wx_2 and P_hx_1 is of greatest importance. Even under the best of conditions the tractor will become unstable and the front end will start to rise as soon as

$$Wx_2 < P_hx_1 \quad \text{.......... (25)}$$

or

$$\frac{Wx_2}{x_1} < P_h \quad \text{.......... (26)}$$

*Fifth of a series of seven articles. The first installment appeared in the January issue. The sixth article of the series, entitled "Dynamics—Supporting Soil Reactions and Drawbar Pull," will appear in the June issue of AGRICULTURAL ENGINEERING. The material presented in these articles was obtained as the result of an agricultural engineering project of the Agricultural Experiment Station of the University of California. It has been edited and approved by the Research Committee of the American Society of Agricultural Engineers.

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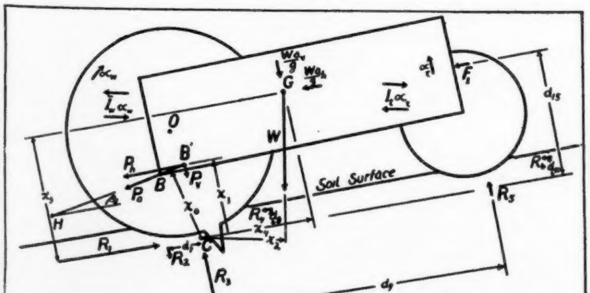


Fig. 19

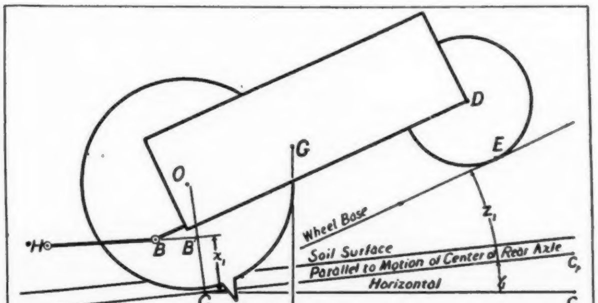
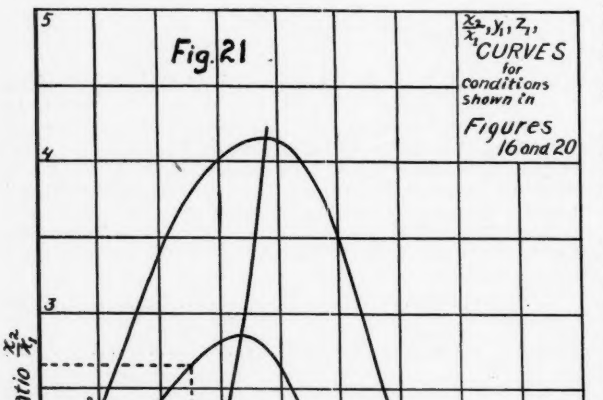


Fig. 20

Since for a given tractor W is a constant, the ratio $\frac{(x_2)}{(x_1)}$ is the factor determining the maximum P_h component of the load resistance which may be attained, under the most favorable conditions, without causing the front end of the tractor to rise. Thus if $\frac{(x_2)}{(x_1)}$ increases as the front end of the tractor starts to rise, the tractor will tend to become stable unless P_h increases, and if $\frac{(x_2)}{(x_1)}$ decreases as the front end starts to rise, the tractor will tend to become more unstable unless there is a corresponding decrease in P_h.

It should be noted at this point that P_h will usually decrease as the front end of the tractor rises, because for a given value of P_h, P_v will be decreased or reversed in direction. This will decrease the supporting soil reaction R_3, which for a given tractor and soil will decrease the maximum possible tractive reaction R_1.

A general equation for $\frac{(x_2)}{(x_1)}$ may be obtained by substituting for x_1 and x_2 their values as given in Equations 12 and 17 of the preceding article of this series. By plotting the values of $\frac{(x_2)}{(x_1)}$ as ordinates against values of z_1 as abscissa, a curve showing the effect of the angle z_1 (angle between the direction of motion of the center of the rear axle and the wheelbase) upon the stability of a given tractor on a given grade is obtained. By plotting a series of these curves for different grades, that is, values of y_1, it is possible to develop a chart showing the relationship between angles y_1 and z_1, and the probable stability of the tractor. Fig. 21 is such a chart, for the drawbar situation and center of gravity location shown in Fig. 20 and in Fig. 16 of the preceding article. For the particular situation being considered, these curves give the value of ratio $\frac{(x_2)}{(x_1)}$ corresponding to any given values of y_1



and z_1; or the value of y_1 corresponding to any given values of $\frac{(x_2)}{(x_1)}$ and z_1, or the value of z_1 corresponding to any given values of $\frac{(x_2)}{(x)_1}$ and y_1. For example, under the conditions to which Fig. 21 applies, if $y_1 = 10$ degrees and $z_1 = 25$ degrees, then $\frac{(x_2)}{(x_1)} \approx 2.66$, or if $\frac{(x_2)}{(x_1)} = 0.5$ and $z_1 = 25$ degrees, then $y_1 \approx 30$ degrees, or if $\frac{(x_2)}{(x_1)} = 2.0$ and $y_1 = 10$, then $z_1 \approx 47.5$ degrees.

Since under usual conditions it is impossible for the drawbar pull, P_h, to be as large as the weight, W, of the tractor, the drawbar hitch and center of gravity location, situation shown in Figs. 20 and 21, should be safe from turning over, due to load resistance alone, up to a grade of about 25 degrees. It is also evident that, if the grade were increased to 30 degrees, the stability of the tractor would be definitely endangered.

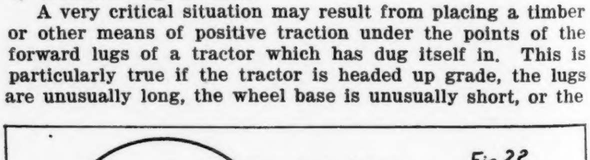
Moment of Inertia of Wheels (I_w). From Equation 22 it is evident that, other factors remaining the same, the smaller I_w is, the greater the potential stability of the tractor under very adverse conditions such as the sudden engagement of the clutch while upon a grade. Since a large I_w in no way adds to the potential magnitude of P_h, except as it increases the weight supported by R_3, it is desirable from the standpoint of stability to have I_w as small as is possible and still maintain the desired strength, durability and diameter of the drivewheels. If more weight is needed to increase P_h, by increasing R_3, it may be added to the frame where it will increase I_t instead of I_w.

Moments of Inertia of Tractor (I_t). From Equation 22 it is also evident that, other factors remaining the same, the greater I_t is, the greater the probability that the tractor will not be overturned even though it starts to rise as a result of an acceleration of the drivewheels, a forward acceleration of the tractor or a temporary increase in the drawbar pull. Thus in general it is desirable that the moment of inertia, I_t, be as large as possible. For example, although the mass distribution represented by the rectangle in Fig. 22 would be no more effective than that represented by the square in preventing the front end of the tractor from starting to rise, it might be the deciding factor in preventing the tractor from overturning under certain temporarily adverse conditions.

Drivewheels in Depression (See Fig. 23). Placing the drivewheels of a front-wheel-drive tractor in a depression increases its stability, if the motion or impending motion is forward, and decreases its stability if its motion or impending motion is backward.

Placing the drivewheels of a rear-wheel-drive tractor in a depression may seriously affect its stability, if its motion or impending motion is forward. The moment arms x_o (of the load resistance) and x_2 (of the weight of the tractor) will both be decreased. In general, the decrease in x_o (the moment arm of the load resistance) will be the greater, preventing the moment $P_o x_o$ (due to the load resistance) from endangering the stability of the tractor. In fact, in many cases the stability of the tractor will be definitely decreased by disconnecting the load.

A very critical situation may result from placing a timber or other means of positive traction under the points of the forward lugs of a tractor which has dug itself in. This is particularly true if the tractor is headed up grade, the lugs are unusually long, the wheel base is unusually short, or the



drawbar load has been disconnected. As may be seen from Fig. 23, at any instant the direction of motion of O (the center of the rear axle will be perpendicular to OC and angle y_1 will be equal to the angle C_yCC_h which the line CC_y makes with the horizontal CC_h, and angle z_1 will be equal to angle $C_yC_sC_h$ which the line CC_y makes with the wheelbase.

As a check on the possibilities of this situation the approximate location of the center of gravity with respect to the front of the rim of the rear wheel of four popular makes of tractors was determined. The results are given in Table II.

Table II

Tractor	Approximate distance of center of gravity in front of the foremost points of rear wheel rims
A	2.7 inches
B	1.8 inches
C	—0.4 inches
D	9.6 inches

Thus it is evident that in many tractors point G is only slightly ahead of the foremost points of the rims of the rear wheels and it is easily possible to create a situation as shown in Fig. 23 where C lies directly below or to the front of G.

As a further check of this situation and of Equation 17, of the preceding article, the rear wheels of a tractor were locked by placing a steel rail between the spokes of the wheels and under the frame of the tractor. The entire weight of the tractor was balanced over the points of the lugs. Fig. 24 is drawn to scale and shows the position of the tractor at the balancing point. The following values were obtained by measurement and from an earlier study of the center of gravity location:

$\beta_1 = 6.6$ degrees; $d_3 = 28.5$ inches; $d_6 = 26.8$ inches; $d_{16} = 6$ inches; $y_1 = 58.2$ degrees; $z_1 = -42.3$ degrees; also $W_3 = 147.5$ and $W = 4079$

It is evident that $W_3d_{16} = Wx_2$.

Substituting for W_3, d_{16} and W,

$(147.5)(6) = (4079)\ (x_2)$

$x_2 = 0.22$ inches

Also from Equation 17

$x_2 = d_6 \cos\ (\beta_1 + y_1 + z_1) - d_3 \sin y_1 - k \cos y_1$

$x_2 = (26.8)(\cos 22.5) - (28.5)\ (\sin 58.2) - (0x \cos 58.2)$

$x_2 = (26.8)(.9239) - (28.5)(.8499)$

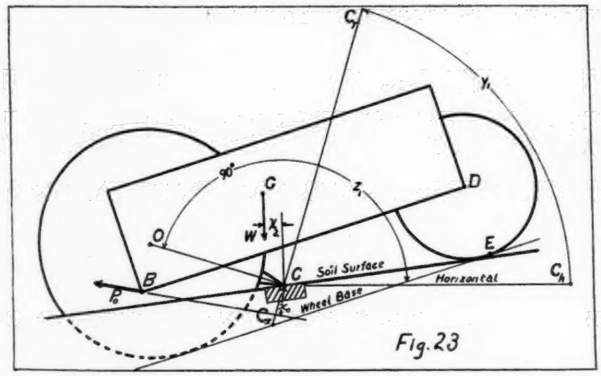
$x_2 = 0.54$ inches

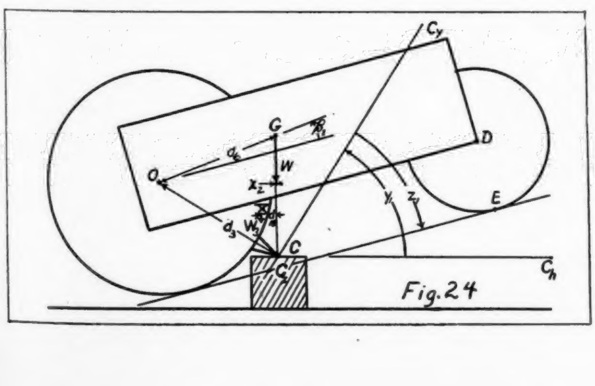
Thus the two values of x_2 check within one-half an inch which is well within the limits of experimental error considering the apparatus used.

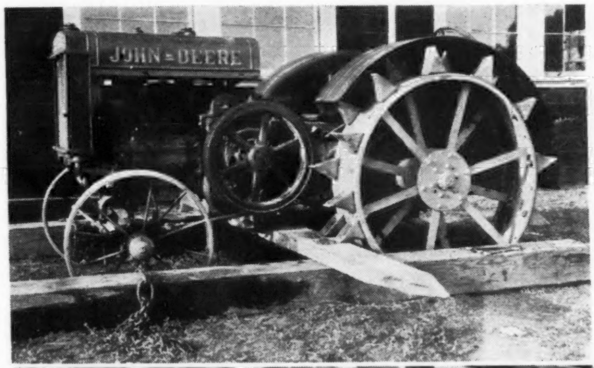
Contrary to common opinion, a tractor which is in such a position that x_2 (the weight moment arm) has a small negative value, can usually be driven out of this position by suddenly engaging the clutch while the engine is running at full speed. A tractor was placed in the position shown in Fig. 25 between two eight-by-tens with a three-by-eight under the lug points and chains passed loosely through the front wheels to prevent the front end rising more than two feet.

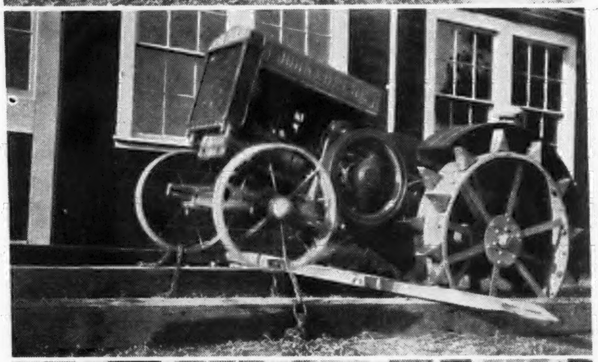
The particular tractor shown was chosen in order to show that the situations discussed below may exist with a well-designed tractor; the author considers it one of the better designed tractors so far as distribution of weight is concerned.

When the clutch was engaged slowly the front wheels of the tractor were lifted from the ground as shown in Fig. 26. When the clutch was engaged suddenly the rear wheels climbed over the obstruction as shown in Fig. 27. These results are explained by the following facts: First, the moment of inertia of the entire tractor about the points of the lugs was less than the moment of inertia of the









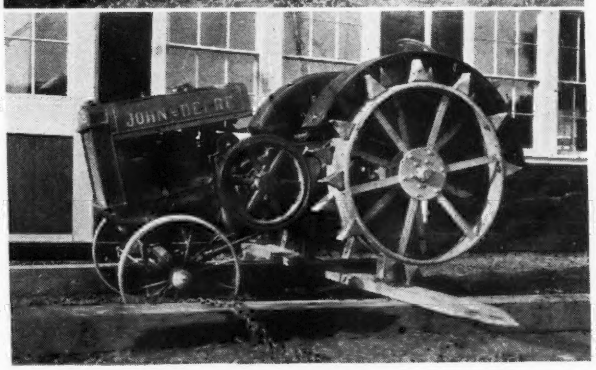


Fig. 25. (Top) Tractor with lug points supported and front wheels chained down

Fig. 26. (Center) Same tractor as in Fig. 25, with front wheels raised due to engaging the clutch slowly

Fig. 27. (Bottom) Same tractor as in Fig. 25, rear wheels having climbed the obstruction due to engaging the clutch suddenly

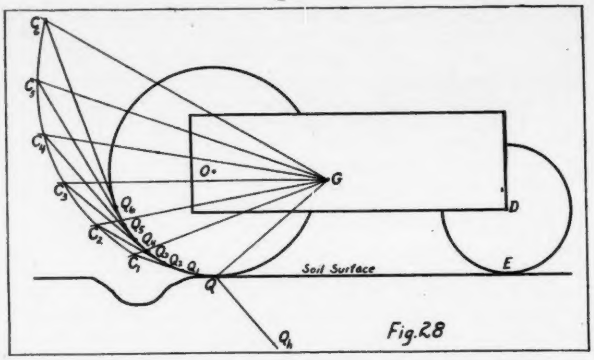


Fig. 28

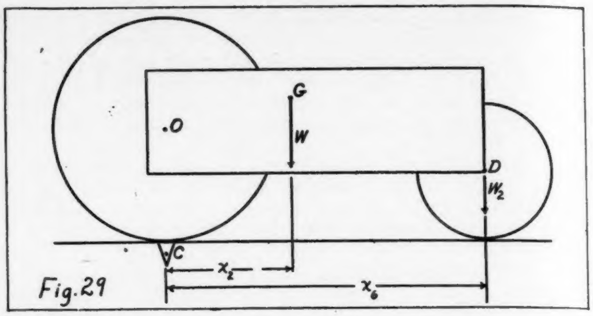


Fig. 29

frame of the tractor about the rear axle; second, the center of gravity was back of the points of lug contact; third, when the clutch was engaged slowly, the rate of acceleration was so small as to make the effect of the moments of inertia unimportant; fourth, when the clutch was engaged suddenly, the acceleration was great enough to make the effect of the moment of inertia of the frame about the rear axle the deciding factor.

However, this does not mean that the average operator should use this plan, for in case the center of gravity were too far back of the point of lug contact, or the difference between the moments of inertia of the tractor about the lug points and the frame about the rear axle was not great enough, the sudden engagement of the clutch would be disastrous. Therefore, in actual practice the clutch should be engaged slowly, and if the front end starts to rise either the point of lug contact, C, (See Figs. 23 and 24) should be moved to the rear, more weight should be added to the front end, or the tractor should be backed out of the depression.

Projecting Frame to the Rear of the Drivewheels. (See Fig. 28.) If there is any probability of the stability of a given tractor being completely destroyed it should be protected by projecting some part of the frame to the rear of the drivewheels. This part should be strong enough to support the entire weight of the tractor. Also, as will be explained below, the part which first strikes the soil, as the front of the tractor rises, should lie to the left of curve C_1C_6 of Fig. 28.

From Fig. 28 it is evident that the steepest grade upon which the tractor can be placed by its own power and traction is equal to angle EQQ_h, where angle GQQ_h is equal to 90 degrees. This grade makes line GQ vertical and places G directly above Q. If the grade is increased, G will lie to the rear of Q and the front end of the tractor will rise. If C_1 represents the point of the frame which first strikes the soil as the front end of the tractor rises, and angle GC_1Q_1 is equal to angle GQE, line GC_1 will be vertical when C_1 strikes the soil, if the grade is equal to angle EQQ_h. Thus if angles GC_1Q_1, GC_2Q_2, GC_3Q_3, GC_4Q_4, GC_5Q_5, GC_6Q_6 are each equal to angle GQE, the curve through C_1, C_2, C_3, C_4, C_5, and C_6 represents the minimum projection of the frame to the rear which can prevent overturnning on the grade whose angle is (90 degrees — angle GQE) or angle EQQ_h. Therefore, if a projection of the frame of a rear-wheel-drive tractor is to be depended upon to prevent overturning, it must be strong enough to support the weight of the tractor and must project to the rear of the curve C_1C_6.

Even though the frame does project to the rear of the curve C_1C_6, a tractor must be handled with care when operating under unusual conditions, for if the clutch is engaged suddenly enough on a grade which is steep enough, or if a depression is present at the point where the frame would normally strike the soil (See Fig. 28), the tractor might be tipped over backward in spite of the frame.

Length of Wheel Base (See Fig. 29). If W = weight of tractor,

W_1 = weight of tractor on rear wheels
W_2 = weight on front wheel
x_2 = moment arm of force W about point C (See Fig. 29)
x_6 = moment arm of force W_2 about point C (See Fig. 29)

Then, $Wx_2 = W_2x_6$ and $W = \dfrac{W_2x_6}{x_2}$

Since for a given tractor W is constant, the value of $\dfrac{W_2x_6}{x_2}$ must be constant. If the wheelbase is increased, x_6 is increased. If x_6 is increased either W_2 must be decreased or x_2 must be increased. If W_2 is decreased W_1 will be increased. This means that the tractive ability of a rear-drive tractor will be increased. If x_2 is increased the negative moment Wx_2 will be increased, and the effect of a disturbing moment such as

P_hx_1 or $\dfrac{Wa_hx_1}{g}$ (See Fig. 19) will be decreased, thus increasing the stability of the tractor.

Therefore, increasing the wheel base increases either the stability or the tractive ability of a tractor, or both. For this reason the wheel base should be as long as possible and still permit a satisfactory turning radius, and ability to cross ridges or checks.

(The sixth article of this series will appear in the June issue.)

Drainage District Lands Being Developed Slowly

IN FIFTY-EIGHT drainage districts in the lower Mississippi Valley and South Atlantic states, the present average annual increase in the area cultivated is about two per cent, according to the U. S. Department of Agriculture in some of its field studies. Development has been particularly slow in districts where farmers have to be brought in to take up the improved land. More rapid progress has been made where drainage has made it possible to extend existing agricultural development. In the area studied, only about 26 per cent of the land made available for cultivation has been brought under the plow.

Anyone contemplating the organization of a drainage district is advised to calculate in advance, as nearly as possible, the probable rate at which the land will be taken up, and to adjust his construction program accordingly. This will make possible a saving of interest on unproductive investments and avoid expensive deterioration on ditches and other improvements which are not in use.

The report of the 1920 Census showed 65,500,000 acres in operating drainage enterprises, of which about 44,000,000 acres was "improved," leaving about 21,000,000 acres available for agricultural expansion. Estimates made by the Department of Agriculture have shown fully as much potential crop land in need of drainage outside of existing districts as the total area in these districts. There are, therefore, about 85,000,000 acres of wet land not now used for producing crops that might be used for that purpose. It has been estimated that the total area of potential crop land not now used for crops is more than 600,000,000 acres. Of this about 30,000,000 acres requires irrigation, but nearly 500,000,000 requires neither irrigation nor drainage. As the present cropped area is about 350,000,000 acres, it is possible to more than double the present crop area without reclaiming more land. Future expansion should take place when and where returns will justify the expense, and this may be, and probably will be to some extent, in all three directions.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Laboratory Investigations of the Influence of Curing Conditions and Various Admixtures on the Life of Concrete Stored in Sulfate Solutions as Indicated by Physical Changes, D. G. Miller (American Society Testing Materials Proceedings, 24 (1924), pt. 2, pp. 847-861, figs. 8).—Studies conducted by the University of Minnesota in cooperation with the U. S. Department of Agriculture and the Minnesota Department of Drainage and Waters are reported.

The results indicate that concrete, regardless of how well cured in water, must subsequently be allowed to dry thoroughly and harden before being exposed to the action of sulfate bearing waters if great resistance to attack is to be expected. It is considered fair to assume that since no evident physical deterioration had taken place at one year in concrete cylinders cured in water vapor at or near the normal boiling temperature for water, the resistance of concrete so cured to sulfate bearing waters is markedly greater than that of water cured cylinders.

The addition of powdered blast furnace slag to concrete up to 40 per cent of the weight of the concrete apparently had little or no influence on the strength and absorption, although the resistance to sulfate water was increased to a degree closely proportional to the quantity of slag added. Ironite added to concrete up to 10 per cent of the weight of the cement had but slight influence on the strength and absorption, although the life in the sulfate solutions increased with the amount of ironite. The life of specimens in sulfate solutions was increased about 20 per cent by adding 4 per cent of calcium chloride or 4 per cent of Cal.

The use of a siliceous material in the form of volcanic ash as an admixture increased the life of specimens nearly 70 per cent when as much as 20 per cent by weight of the cement was added. The results were negative for amounts less than 20 per cent, and the resulting loss in strength was about 30 per cent, so that it is considered probable that the utility of this material as a means of developing resistance to sulfates is very limited.

Both high calcium and high magnesium hydrated lime gave negative results on the life of concete in sulfate solutions when used in proportions of 5 and 10 per cent. Alkagel A in the proportions of 1.5 and 3 per cent also gave negative results as did water-gas tar in the proportion of 5 per cent.

Twenty per cent of water-gas tar caused more than 50 per cent of loss in the strength of concrete cylinders, although the life of the specimens in the sulfate waters was about 50 per cent above that of normal cylinders due to the water repellent qualities. However, the results are taken to indicate that the use of water-gas tar is not feasible owing to the great strength loss caused.

Electricity in Oregon Agriculture, G. W. Kable ([Corvallis]: Oregon Committee on Relation of Electricity to Agriculture, 1926, pp. 48, figs. 22).—This is the 1926 annual report of the Oregon Committee on the Relation of Electricity to Agriculture, the investigational work of which is conducted by the Oregon Experiment Station.

In the work with electricity in poultry raising, the use of electric lights in laying houses during the short winter days has been found to result consistently in increased egg production. The cost of power for lights and extra feed consumed is relatively small compared with the increased returns, the cost of installing the lights being a more important item of expense. Electric brooders have been found satisfactory if properly operated. Electricity for brooding usually costs more than oil, but eliminates much of the labor and most of the fire hazard.

Studies on the use of electricity in horticulture have shown that the capacity of a dehydrator is approximately doubled by recirculating part of the heated air with a fan. The amount of fuel used per ton of dried product is decreased, the operation of the dehydrator is under better control, and the dried product is usually better and more uniform where the air is recirculated. The construction cost of dehydrators per ton capacity is less for the recirculation than for the natural draft type. The use of electric motors as sources of power for driving fans has been found to introduce greater reliability for continuous service, more uniform power, and lower cost for labor in operating and for repairs. Electricity for lights and for power to operate oil burners, water pumps, traying machines, graders, and washers in dehydration plants has been found to save labor and result in a better product.

The electric power required for grinding feed with mills now on the market has been found to average a little more than 0.5 kilowatt-hour per 100 pounds of grain. Feed can usually be ground in less time than it can be sacked, hauled to town, and returned.

Work with electric hay hoists showed that an electric hay hoist will replace a team and possibly an extra man and horse during haying. The power used in putting hay in the barn was less than 0.5 kilowatt-hour per ton. It was found that a hay hoist should be simple, and the power required should be no more than 5 horsepower and preferably 3 horsepower. A satisfactory hoisting speed is from 150 to 200 feet per minute, and the pullback speed should be no greater than the hoisting speed. The drums should be not less than 6 inches in diameter and preferably larger. It is not essential to have a clutch on a single-drum hoist if there is a sliding gear to free the drum. Drums should always be provided with brakes and should be free running when the clutch or pinion is disengaged. In large barns and where large amounts of hay are handled, a double-drum hoist with cable speeds of 200 feet per minute is desirable.

Other data are reported on electric pumping for irrigation, hoisting earth from a well, the operation of silage cutters, elevating grain and shavings, and shearing sheep.

[Agricultural Engineering Studies at the Illinois Station] (Illinois Station Report 1925, pp. 129-143, figs. 2).—The progress results of a number of studies on different features of agricultural engineering are briefly summarized.

In work on tandem hitches it has been found that short levers should be avoided, especially when used to distribute the pull between the front and rear horses, and that in working out four-three and four-four teams on three-bottom plows such side draft as must be taken by the team should, for the most part, be placed on the lead horses. Supporting the front evener and the lead rod when turning at the end has not been found so important a factor as it might appear. It is considered doubtful that on the average farm a team should be strung out more than the length of two horses. The pulley has been found to have some advantages as an evener between the front and rear horses.

The work on the drying of soft corn has indicated that in general drying with forced unheated air is a slow and costly process when the temperature is low and the humidity is high.

Data are also reported on the use of electricity in agriculture, the development of electric water systems, two-chamber septic tanks, plow draft under different conditions, the development of terracing practices, machines used in soy bean growing, and thresher adjustments.

Safety Rules for the Installation and Maintenance of Electric Utilization Equipment (U. S. Department of Commerce, Bureau of Standards Handbook 7 (1926), pp. V + 71).—This handbook contains safety rules for the installation and maintenance of electric utilization equipment and the grounding rules of the fourth edition of the National Electric Safety Code.

Poultry House Ventilation and Construction (Nebraska Station Report 1925, pp. 9, 10).—Studies are reported in which eight units of similar construction and arrangement were used. In each of these an equal number of hens of the same breed and strain were housed. In four of the houses equipment was installed to study the effect of minimum temperatures on egg production. Minimum temperatures of 70, 60, 50, and 40 degrees Fahrenheit were maintained. The best egg production for a period of two months was obtained from the house in which the minimum temperature was 60 degrees. Among the other four houses one was heated with a stove, one was equipped with electric lights which were automatically switched on at 4 A.M., and one was tightly closed from 4 P.M. to 7 A.M. each day. Of the entire eight houses, the one with the increased day furnished by the electric lights gave the highest production.

United States Government Master Specification for Varnish, Spar, Water-Resisting (U. S. Department of Commerce, Bureau of Standards Circular 103, 4: ed. (1926), pp. 6).—The text of the specification is given.

Preliminary Report of an Investigation Into the Artificial Drying of Crops in the Stack (Oxford University, Institute of Agricultural Engineering, Bulltin 2 (1926), pp. 104, pls. 8, figs. 32).—Studies conducted by the Institute of Agricultural Engineering of the University of Oxford, England, are reported.

In the first series of experiments air at atmospheric temperature was successfully used for the drying in the stack of peas, beans, and cereals, but it is considered highly questionable whether any dependence can be placed on the method, since under adverse weather conditions the results have been a failure. In cold damp weather or under conditions where the natural heat of a stack was low the method proved totally inadequate.

The second series of experiments dealt with the use of heated air. The average air temperature was 67 degrees F. at 85 per cent relative humidity, and the temperature of the heated air at the duct was 97 degrees. The volume of air used was 2,800 cubic feet per minute. The number of stacks dried successfully demonstrated the practicability of the system. During the course of the experiments the volume of air supply was increased to 5,000 cubic feet per minute.

A third series of experiments showed that when there was sufficient heat and volume of air so regulated as to obtain the necessary heat reaction inside the material the drying was successful.

Laboratory studies on the development of the drying apparatus showed that with cylindrical and conical chambers the slope of the center chamber did not influence the formation of eddy currents if

the blast of air was previously allowed to spread gradually in the duct without losing its stream line motion, and provided the velocity of the air was low.

The penetrability of a stack was found to vary according to its height. With an equal thickness of stack around a cylindrical center chamber the penetrability at the bottom was less than at any point higher up. The design of the center chamber was found to be influenced by the fact that the action of rapid drying caused a stack to consolidate quickly and decrease in height within a few hours. It was therefore necessary to design the center chamber so as to insure equal distribution of the air after consolidation had taken place. It was found that with the sloping trench opposite the duct outlet there was a considerable amount of turbulence inside the center chamber. When the sharp angles of the trench were rounded off a satisfactory distribution was obtained. Within certain limits an increase in the velocity of the air delivery appeared to have little effect on turbulence.

It was found that during the drying of sugar beet cossettes the resistance gradually decreased as the moisture content was reduced and the dried material had a resistance approximately equal to 25 per cent of that of the original wet material. The shrinkage during drying was approximately 50 per cent. Wet and dried cossettes obey the same laws with regard to air velocity and thickness of material.

Experiments on the porosity of hay showed that to avoid undue resistance to the passage of air the average velocity of the air through the material must not exceed 20 feet per minute. This fact definitely fixes the size of the center chamber for a given mass of hay.

It was further found that a temperature of 150 degrees with any quantity of moisture present will effectively kill germination in seeds and a temperature of 140 degrees in the presence of moisture will greatly reduce germination, rendering the grain unfit for malting purposes. However, when a temperature of 120 degrees is reached in a moist state there is an increased speed of germination and a more uniform sample is produced. Heating in a dry state appeared to cause little actual damage to the seeds, aside from a slight retardation of germination. It was found that in practice if the duct temperature is 160 degrees the cooling effect due to evaporation considerably reduces the air temperature, and not until the material has a reduced moisture content does the stack temperature approach that of the ingoing air. Therefore a duct temperature of 140 degrees is considered to be perfectly safe for crops grown for seed.

Several appendixes relating to supplementary experiments and to the mechanical details of the apparatus used are included.

[Agricultural Engineering Studies at the Illinois Station] (Illinois Station Report 1926, pp. 121-137, figs. 3).—The progress results of a number of agricultural-engineering studies at the station are briefly summarized which include data on electrically driven equipment, farm septic tanks, methods of working large teams, plow draft, terracing, waste caused by inefficient threshing, the use of the combine for soy bean harvesting, seed cleaning, and artificial curing of seed corn.

Some of the outstanding results obtained are that the 2-chamber septic tank is the best farm type. It was found that 7 and 8-horse teams will prove of practical size for plowing and other field work on many Illinois farms. Seven horses can be used to pull three 12-inch bottoms and eight to pull three 14-inch bottoms with little if any more side draft than when six horses are used on two 14-inch bottoms. The larger team can apparently be driven quite as easily as five or six horses in tandem. Plow draft was found to vary under different rotations.

Blanket tests made in representative sections of the state showed threshing losses as high as 4.05 per cent for wheat and 10.28 per cent for oats. In nine cases the adjustment of concaves reduced the loss and better feeding reduced the loss in eight cases. An increase in cylinder speed, closing of wind boards, raising of tail boards, and other adjustments also gave results. The combine was found to give promise for soy bean harvesting. The loss of soy beans was much less when they were harvested with the combine harvester-thresher than when harvested by any other method. The cost of harvesting soy beans with the combine was about one-third of that with the ordinary methods.

The tests of the artificial curing of seed corn showed that germination of the corn dried by 79.4 hours of forced heated air at 93 degrees Fahrenheit was not damaged. The seed dried by 207.6 hours of forced unheated air germinated 19.2 per cent below normal. The germination of seed which was allowed to dry by natural ventilation was injured to the extent of 18 per cent. In drying shed tests the most effective method of reducing the moisture content and of preventing injury to germination of the seed was when forced heated air was used.

Precipitation Versus Snow Surveys for Predicting Stream Discharge, J. C. Alter (U. S. Weather Review, 54 (1926), No. 4, pp. 160, 161).—"This paper is the result of an inquiry as to the comparative value of precipitation records and snow surveys for predicting the flood-time discharge of Big Cottonwood Creek, one of the major sources of Salt Lake City's water supply. The inquiry has resulted rather decidedly in favor of precipitation records where they are available in proper numbers and places, though the snow survey shows a valuable correlation factor." It is pointed out, however, that "snow measurement sites or stations, like precipitation stations, should be regarded as indicators only; though where their locations are suitable, very good results may be obtained. Furthermore, where there is a scarcity of precipitation records or the tenure of precipitation stations is insecure, the snow survey is, in most watersheds, a convenient and satisfactory substitute."

Experiments in rice culture at the Biggs Rice Field Station in California, J. W. Jones (U. S. Department of Agriculture Bulletin 1387 (1926), pp. 39, figs. 8).—Supplementing previous reports, soil and meteorological conditions at the Biggs Rice Field Station are described, and the results of seeding, weed control, irrigation, and varietal and crop-sequence tests with rice are summarized.

The best method of irrigation on foul land seems to consist of continuous submergence after broadcasting the rice on the soil. Probably rice should be sown at a heavier rate when grown by continuous submergence than when grown by deferred submergence by the old method of irrigation. Seeding experiments with three varieties suggested the rate of one hundred fifty pounds per acre when rice is grown on old land by the old method. Broadcasting comparatively early was indicated.

In experiments on seedbed preparation for rice grown by continuous submergence the best yields were had on well-prepared land on which the rice was broadcasted and immediately submerged four to six inches. On unprepared or poorly prepared seedbeds such weeds as spike rush, cat-tail, and slender aster reduce rice yields below profitable limits. On land foul with cat-tail, a heavy rate of seeding (two hundred pounds per acre) did not help to eradicate the weed, but good stands of rice do help to prevent cat-tail from becoming established on a clean rice field. Continuous cropping tests indicated that profitable rice yields can not be made longer than six years in succession by the old methods of irrigation, even when weeds are controlled, and that continuous cropping probably will not be practicable when irrigating by continuous submergence.

The varietal experiments showed that medium-grain and long-grain rices are not so well adapted to California conditions as the short-grain rices. Agronomic data are tabulated for six varieties grown during the period 1918-1924. Of varieties and selections of early, midseason, and late short-grain rices grown on small increase plats from 1920 to 1924, inclusive, midseason selections made the highest average yields and the late group ranked second. Varieties grown on bur clover land averaged 1,778 pounds more per acre, or 38 per cent, than when grown on mung bean and soy bean land. Bulk rows produced higher average yields per row than head rows in the rice nursery, apparently because of heavier seeding. In general, midseason and late short-grain varieties and selections gave higher average yields in the nursery than the medium or long-grain types.

Experiments With Dairy Products at the California Station (California Station Report 1925, p. 50).—Investigations by A. W. Farrall of the power, steam, and water requirements of three types of standard milk can washing and sterilizing equipment showed that the average steam consumption varied from 3.64 to 5.59 pounds, the average water consumption from 1.08 to 4.06 gallons, and the electric power consumption from 0.0236 to 0.00045 kilowatt per 10-gallon can.

Poultry Houses and Equipment, N. R. Mehrhof (Florida University Agricultural Extension Bulletin 45 (1926), pp. 20, figs. 17).—Practical information on the planning and construction of poultry houses and equipment to meet Florida farm conditions is presented, together with working drawings and bills of materials.

Equipment for Excavating Marl, H. H. Musselman (Michigan State Quarter Bulletin, 9 (1926), No. 1, pp. 17-21 figs. 2).—A brief description is given of a mobile outfit for excavating marl developed at the station, which is said to be in use for the third season with considerable success.

Summer Tillage Implements, A. J. Ogaard (Montana Agricultural College, Extension Circular 79 (1926), pp. 43, figs. 61).—Information relating to various types of implements being used for summer tillage by many dry land farmers throughout the Northwest is presented.

The Role of Graphite in Lubrication, F. L. Koethen (Industrial and Engineering Chemistry 18 (1926), No. 5, pp. 497-499, figs. 6).—Tests on a Riehle machine to determine the amount of pressure required to rupture the fluid film in a 3-inch bearing rotating at constant speed and measurements of the coefficient of friction of weighted sliders, in each case using oil with and without suspended graphite are reported.

Both methods of test showed that under conditions of ruptured film lubrication with some solid-to-solid contact the presence of graphite substantially reduced the friction. Graphite was found to be effective in prolonging the period of unbroken film lubrication and in the ruptured film stage reduced friction and minimized metallic contact. This is explained on the basis that it deposits to a certain extent in the low places of the metal, thus making a smoother surface, and that when solid-to-solid contact does take place it abrades more readily and with less friction and damage than would plain metal surfaces.

Strengthening and Indurating Concrete with Sulphur, W. H. Kobbe (Engineering News-Record, 96 (1926), No. 23, pp. 940-942, figs. 2).—The results of tests extending over a number of years are briefly summarized which indicate that concrete may be impregnated with sulfur with an increase in strength and decrease in absorption. Commercial flour of sulfur, or sulfur in any other form, added to the mix has little or no effect on the strength even though this contained sulfur is subsequently melted. In carrying out the sulfur treatment the precast concrete products, preferably well cured, are immersed in a bath of molten sulfur until the requisite degree of absorption has resulted. The treatment is applicable to all types of concrete and cement mortars, including high alumina cement, and with any aggregate chemically inert toward sulfur.

The Use of the Dynamometer in Soil Cultivation Studies and Implement Trials, B. A. Keen (Journal of Royal Agricultural Society of England, 36 (1925), pp. 30-43, figs. 3).—An account is given of studies conducted at the Rothamsted Experimental Station on the use of the dynamometer in studying the factors involved in the draft of implements in soil cultivation.

The conclusion is drawn that if careful attention is given to adjustments in the dynamometer the variations in drawbar pull obtained on the chart can be definitely ascribed to variations in the soil resistance. Variations in hitch and set of the implement were found to have no measurable effect on the drawbar pull unless the depth of working was affected. Tests on adjustment of depth alone showed that over the normal range the drawbar pull was proportional to the depth. The slope of the land was found to have no effect on the drawbar pull for gradients up to one in forty. The effect of speed was also slight. An increase of from 2.5 to 4 miles per hour caused only a 7 per cent increase in drawbar pull. It is considered unlikely that the cost of the extra fuel needed to sustain this 7 per cent increase would be more than a small fraction of the saving.

In order to express this work a power factor was used which is defined as the product of drawbar pull and the time in seconds required to plow 1 foot length of furrow. It was found that in many cases this factor is more sensitive than drawbar pull alone. It is closely related to fuel consumption and can therefore be used when the costs of various operations are being compared.

The studies of the degree of uniformity of soil resistance on different fields showed that visual inspection is quite unreliable as an indication of uniformity.

The changes in drawbar pull across the field were found to reflect corresponding changes in the physical properties of the soil. Since the latter have an effect on the growth of plants, a relationship was found between drawbar pull and plant growth, especially in its early stages. For instance, the number of plants of winter wheat that survived the winter was greatest on those soils having the lowest drawbar pull, and the same relationship held for percentage of tillered plants. As growth proceeded the closeness of the relationship fell off until at harvest they were not related significantly to the drawbar pull.

Airplane Dusting in the Control of Malaria Mosquitoes, W. V. King and G. H. Bradley (U. S. Department of Agriculture, Department Circular 367 (1926), pp. 16, figs. 8).—This is a report of experiments conducted during 1923 and 1924 in the vicinity of Mound, La., in which Army DeHaviland 4-B planes, operated by U. S. Army Air Service pilots, were used. These planes had been adapted for cotton dusting by installing metal dust hoppers in the rear cockpits, with an arrangement provided for releasing the dust through the bottom of the fuselage. The insecticide was Paris green mixed with an inert dust, in most cases a finely ground silica earth, as a diluent and carrier. Road dust and a mixture of lime and flour were tried in a few cases with fairly good results, but it seemed desirable to obtain a substance more uniform in quality and more certain as a source of supply than the former, and there was a tendency for the flour and lime to become packed in the hopper. The authors' experience indicates that approximately 0.5 pound of Paris green per acre will give a safe margin for the treatment of such places as rice fields and the more open parts of the lakes, the quantity being increased as necessary where the breeding area is protected by a growth of trees and brush.

It was found that a given area could be covered rather thoroughly with the dust, and that by taking advantage of a light breeze a wide strip could be treated with each trip of the plane. A wind velocity as high as from ten to fifteen miles per hour was, however, a disadvantage in making the dust applications, and the operations were usually discontinued when the stronger winds were blowing. The results of the entire series of tests in the reduction of larvae were variable, owing in part to the failure of the dust to reach all of the area under observation and in part to an unsatisfactory lot of Paris green which was used in a number of the experiments and which proved to have a very low toxicity for the larvae. With an experienced pilot, and when careful attention was given to the spread of the dust, no special difficulty was encountered in distributing the dust over the treeless parts of the lakes. Furthermore, from a single experience in treating rice fields, this type of breeding place appears to be particularly well adapted to control by airplane dusting because of the absence of trees and other obstructions which interfere with close flying. Even in heavily wooded areas, when enough dust was used to offset the considerable wastage due to adherence to the leaves and to wind drift, it was found to have penetrated the thick growth and to have reached the water in sufficient quantities to destroy the larvae.

"The two final tests of 1924 gave particularly clear-cut results, and for this reason were of special interest in showing the possibilities of this method of control in breeding areas of the type represented, the lakes being overgrown with aquatic vegetation and having an abundance of Anopheles larvae well distributed throughout. In the first of these a larval reduction of 88 per cent occurred as a result of the treatment, and in the second over 99 per cent were killed, as estimated by the writers' method of examination. The only larvae remaining in the second instance were a few of the smallest size, which were found in one small spot. In each test a series of pans containing a counter number of larvae were distributed over the lake as a further check on the effectiveness of the poisoning. In the first test 92 per cent of these larvae were killed, and in the second all were destroyed."

Motor Carbon Deposits Formed Under Controlled Conditions from Typical Automobile Oils, C. J. Livingstone, S. P. Marley, and W. A. Gruse (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 502-504, figs. 3).—Apparatus developed at the Mellon Institute of Industrial Research is described which consists of a small single cylinder motor provided with a special lubricating system, permitting circulation of a very small charge of lubricating oil, and with devices enabling the very close control of the head, oil, and intake temperatures, the amount of fuel, and the composition of the fuel mixture, as well as the load on the motor and its speed. The modified motor can be so operated as to permit close duplication of conditions, and with a given lubricating oil the carbon deposits in the combustion chamber can be checked very closely in a series of runs.

By use of this apparatus results are reported from which the belief is expressed that there is a close connection between the volatility of an oil and its carbon depositing tendency. If an oil contains a fair proportion of hydrocarbons nonvolatile at the prevailing temperature of the metal surface, such as a steam refined cylinder stock, this residue will progressively crack and oxidize to sticky and asphaltic materials which will gradually bake into dense, adherent deposits. If, on the other hand, the oil can distill off fairly cleanly it will probably take much longer to produce a deposit of equal thickness. In addition it appears that a deposit from such a volatile oil will contain a small amount of binding material, and will therefore be more friable than a deposit from a higher boiling oil.

Centrifugal Pump Tests, H. E. Murdock (Montana Station Bulletin 190 (1926), pp. 22, figs. 15).—Data from tests of a number of horizontal and vertical centrifugal pumps are reported and discussed and the test methods described.

Tests of Fertilizer Spreaders and Grain Binders, Martiny and Fischer, Arbeiten Deutschen Landwirtschafts-Gesellschaft, No. 330 (1925), pp. 68, figs. 42).—Comparative service tests of a number of different makes of fertilizer spreaders and grain binders are reported.

The fertilizer spreader tests showed that with heavy fertilizer applications distribution was generally quite uniform, but that uniformity of distribution decreased as the size of application decreased. This was especially true with such materials as lime and kainit. Uniformity of distribution was found to depend on the discharging apparatus and vibration of the machine, the uniformity of speed of operation, and the nature of the fertilizer.

The binder tests showed that German machines gave as good results as American machines.

Single Grain Seeding Machines, A Nachtweh (Deutschen Landwirtschafts 51 (1924), Nos. 12, pp. 126, 127; 13, pp. 137, figs. 5; 15, p. 160, figs. 10; 16, p. 174, figs. 10; 17, pp. 186, 187, figs. 7; 18, p. 187, figs. 2).—A review of the history of the development of single grain seeding machines is given.

Power and the Viscosity of Oil, W. F. Parish (Industrial and Engineering Chemistry, 18 (1926), No. 5, pp. 525, 526, figs. 2).—Studies are briefly reported from which the conclusion is drawn that the value of the lubricant for use under modern conditions in continuous lubrication systems is not entirely indicated by the viscosity of the oil when new.

The Weight and Lateral Pressure of Sunflower Silage, H. E. Murdock (Montana Station Bulletin 191 (1926), pp. 19, figs. 5).—Tests of the weight of sunflower silage and the pressure it exerts on the walls of silos are reported.

The results showed that, when thoroughly compacted, sunflower silage weighs from one and one-half to three times as much as corn silage. The lateral pressure on the walls of silos holding sunflower silage was found to be much greater than it has been assumed to be for corn silage, and for tall silos it is more than twice as great. The deductions from these two findings are that a silo of any given dimensions will hold in the neighborhood of from one and one-half to three times as much sunflower silage by weight as it will of corn silage. The hoops or the reinforcing used in building a silo for sunflower silage should, however, be nearly double those used in building a corn silage silo.

Tables and formulas are presented giving the sunflower silage capacities of various sizes of silos and the methods of calculating the amounts of hoops or reinforcing needed in consrtucting such silos.

Cost of Producing Field Crops in Three Areas of Illinois, 1913-1922, E. Rauchenstein and R. C. Ross (Illinois Station Bulletin 277 (1926), pp. 39-67, figs. 8).—A study is made of the relative profitableness of crops under prevailing farm practices based on detailed cost records kept on from six to ten farms each in Franklin and Hancock Counties for the period 1913-1922, and on from ten to fifteen farms in Champaign and Platt Counties for the period 1920-1922. The data are summarized for the entire period and for the pre-war, war, and post-war periods, 1913-1916, 1917-1919, and 1920-1922. The counties chosen are typical of three agricultural sections of the state having different soils, land values, and systems of farming.

The costs are grouped under the heads of man labor, horse labor, tractor, seed, machinery, fuel, twine, threshing, general farm expense, miscellaneous expense, and interest on land; and the incomes under grain or seed, roughage and pasturage. The following efficiency factors were determined for each crop: Net cost, price, and profit per bushel or ton, yield, man and horse labor, and tractor use per acre, and man labor per bushel or ton. The variations in costs on different farms and the effect of yield and of operating expense on cost are discussed, and four and five-year crop rotation systems are worked out for each county.

News of the Annual Meeting

University Farm, St. Paul, Minn.—June 22-25, 1927

Annual Meeting Plans Progressing Nicely

IN PLANNING the program for the 1927 annual meeting of the American Society of Agricultural Engineers there has been a departure from established custom, in that the general sessions have been grouped together into a nucleus around which are grouped the other main features of the program. In this way it was thought to maintain a more centralized interest in the program of the general sessions by doing away with the apparent necessity of dividing the interests of the various technical groups between the topics of broad, general interest and those of more restricted, technical interest closely impending in a divisional session. In line with this policy there will be no general session until the second day.

Monday and Tuesday, June 20 and 21, the national Committee on the Relation of Electricity to Agriculture will hold its annual meeting at St. Paul, which will include a trip on the Red Wing experimental line on June 20.

Program of the First Day

The regular meeting of the Society will open Wednesday morning, June 22. The early half of the forenoon will be given over to registration of the visiting members and their families, coupled with the usual reception and visiting features. The latter part of the forenoon will be occupied by regular sessions of the Rural Electric and Reclamation Divisions, running simultaneously, in which most of the time will be consumed in regular committee reports and discussions of plans for the new year. Each committee has been asked to make its report as definite and concise as possible and to include a recommendation of a definite project or part of project as the work of the committee for the new year.

In the afternoon of that day the Rural Electric and Reclamation Divisions will again convene for the entire afternoon period in their regular technical sessions. As papers given at the meeting will eventually be published in the Society publications or otherwise made available for distribution, all those presenting papers before the technical divisions will confine their verbal presentations to a maximum time allowance of twenty minutes in each case, thus allowing an interval of about fifteen minutes between papers for discussion of the paper just presented and for answering questions pertaining thereto. The afternoon session will close at five o'clock.

At 6:30 P.M. there will be a picnic supper for all present at University Farm campus with opportunity for a social hour and renewing of old acquaintances. It is even rumored that the University of Minnesota Division of Agricultural Engineering has expressed its willingness to accept the challenge of the world to a kittenball game preceding the picnic supper.

The evening, from 8:00 to 10:00 P.M., will be given over to various special conferences and meetings, such as the heads of college agricultural engineering departments, land clearing conference, consulting engineers session, and student members session.

The General Sessions

The entire daytime program of the second day, Thursday, June 23, will be devoted to general sessions. The regular morning session at 9 A.M. will be opened by the welcoming address of Dean Coffey of the Minnesota Department of Agriculture, who will speak on "Significant Changes Taking Place in Agriculture." President Sjogren will follow with his annual address, and he in turn will be followed by one or two other addresses of general interest to all agricultural engineers. The morning session will close at 11:00 o'clock.

At 1:30 in the afternoon the entire Society will again convene in general session which will last until 4:30 P.M.

The program of these general sessions will include outstanding addresses by various prominent men outside the Society membership, and it is confidently expected that among these will be one federal cabinet officer, one or more speakers from foreign lands and other industrial leaders in our own country.

Dinner conferences will be the order of the day from 5:30 to 7:30 P.M. Among these will be a special conference of extension workers which will be correlated with the regular session in the College Division program the last day.

The evening session the second day will be given over to the annual business meeting including the report of the secretary-treasurer, the customary special and standing committees, A.S.A.E. representatives to other organizations and the general business of the Society.

The Third Day

On Friday, June 24, the third day of the meeting, will be held the sessions of the Farm Machinery and Farm Structures Divisions, running simultaneously.

At 3:30 P.M. an inspection trip will be taken to the Bowman Farm near Lake Minnetonka.

One Official Tour

There is one official trip scheduled for Friday afternoon from 3:30 to 6:30. It will consist of a visit to the experimental peat plots and to the Bowman farm buildings. They are both located on the same route which includes a drive around a part of Lake Minnetonka. At the peat plots unique experiments are being carried on by the division of agricultural engineering of the University of Minnesota in cooperation with the divisions of agronomy, horticulture and botany and plant pathology in the cropping of peat with the water table artificially held at certain fixed levels. On the Bowman Dairy Farm is located a set of well-constructed farm buildings which is especially adapted to the production of milk on a large scale, under strictly sanitary conditions.

The Closing Session

The morning of Saturday the fourth and closing day of the meeting, will be given over to the College Division program

Front view of the agricultural campus of the University of Minnesota at University Farm. From left to right, dormitories and tennis courts, administration building (center), agricultural engineering building (A.S.A.E. 1927 annual meeting headquarters, and Haecker Hall (dairy)

featuring resident teaching problems in agricultural engineering.

During the noon hour the officers and officers-elect of the Society will meet in cabinet luncheon to plan the work of the new year.

In the afternoon the regular program on extension work in agricultural engineering will occur under the auspices of the College Division.

It is aimed to close the final session in ample time on Saturday afternoon to enable those who must leave early to make the regular Saturday afternoon and evening trains from the twin cities.

Entertainment and Recreation

It must not be assumed from the foregoing discussion that the entertainment and recreational features have been overlooked, for such is not the case. It is confidently expected that more of the members than ever before will be accompanied this year by their wives, for we do not forget that Minnesota, the land of the ten thousand lakes, is the playground of America.

The resident wives of the Agricultural Engineering Division at University Farm constitute a ladies committee who will meet the visiting ladies and provide for their comfort and entertainment. It is planned that the first day will be devoted to informal visiting and getting acquainted while resting from the journey, with the picnic supper in the evening in the way of entertainment.

For the second day provision has been made to take the ladies on a tour of the Twin Cities and Lake Minnetonka, where they may enjoy a short boat trip on the lake. A box lunch will be served either on the boat or in one of the picnic parks on the lake shore.

The day will close for the ladies with a reception from 8 to 10 o'clock in the fireplace room of the home economics building where the visiting ladies will meet the women of the staff and faculty wives of the various departments of the Minnesota station.

It is expected that some of the features of the regular program on Friday, the third day, will prove attractive to the ladies, but opportunity will also be given them for informal trips by automobile to points of interest in the twin cities, such as the parks, art galleries, etc.

This opportunity will be repeated on Saturday, the last day of the meeting, at which time also shopping trips may be made if desired.

For exercise and recreation, the tennis and hand ball courts of the college will be available at all times for men and women alike. The swimming pool in the gymnasium at University Farm, and nearby lakes, will be available to the visiting guests. Those having bathing suits should bring them. The University golf course is but three-fourths of a mile away from University Farm over a good road, while the various golf courses of the twin cities are easy of access by automobile.

The annual banquet on the third evening will be followed by an informal dance in the banquet hall at University Farm.

On another page will be found the details of the preliminary program of the meeting stated as definitely as it is possible to do at this time.

Suggested Inspection Trips and Outings Following the Meeting

It is the purpose here only to outline very generally some of the trips and possible outings which may be attractive to those attending the 1927 A.S.A.E. meeting. Detailed information of these and other trips will be available later.

Agricultural resources of Minnesota are many and varied. The state is particularly noted as a dairy state and for the high-grade butter produced. For those interested in this phase of agricultural work opportunities will be provided for inspecting the buildings and equipment of some up-to-date commercial plants.

Reclamation engineers and soils men will have a chance to see work under way and accomplished in reclaiming Minnesota peat. Inspection trips of water controlled peat plots near Minneapolis and of the commercially developed project of Hollandale near Albert Lea have been planned for those interested.

Those who have the time will be interested in a visit to Duluth, the head of navigation on the Great Lakes. It is but a short trip north and west from Duluth to the Iron Range where operation of some of the great open pit iron ore mines may be viewed from numerous points along excellent highways. The largest open pit mine in the world can be seen at Hibbing which is on a concrete highway and about four hours from Duluth.

Minnesota affords many unusual opportunities for pleasant outings of different kinds during the summer months. Conditions out of doors here are never more favorable than the last of June and early July as ordinarily the weather is settled, the days warm and clear and the nights cool. Spring has truly only just turned to summer at this time of year in this latitude and the smell of freshness of new growth of all kinds is still in the air. It is the season when the fisherman is in his glory with unlimited opportunities to fish innumerable lakes for almost all varieties of fish common to fresh water. It is the season when bathing and boating are most enjoyable and when hiking and motoring through the virgin forests and cut over areas have greatest appeal. For the motorist conditions in Minnesota are nearly ideal as almost all highways are gravel or concrete. A motor trip in July along the north shore of Lake Superior is an experience never to be forgotten. Those who plan outings in early July can be accommodated at many different lakes whether to camp, to rent furnished cottages, or to live at resort hotels.

The following are a few more or less definitely outlined trips that will prove of interest to those contemplating an outing in Minnesota following the meeting:

Tentative Suggested Trips Following Meeting

(These trips are not official and will not therefore, with the exception of the first, be personally conducted)

1. **Dairy and Drainage Trip.** (Two days). South on Jefferson Highway to Peat Drainage and Development Project at Hollandale, and thence to state creamery at Albert Lea, thence west to Blue Earth and north to New Ulm via Mankato and return to twin cities via Glencoe and Chaska. Large commercial dairy plants may be visited at Mankato and Glencoe and short stops may be made at other points of interest along the route.
2. **Iron Range Trip.** (Four days). Twin cities to Duluth to Virginia, Hibbing (largest open pit iron mine in the world), Grand Rapids, Aitkin, Vineland, (Indian trading post) Milaca, Elk River, Anoka and twin cities.
3. **Arrowhead District Trip.** (Mines and forests and lakes, five to seven-day trip). Twin cities to Duluth (North shore drive to Two Harbors, Little Marais) and then through the Superior National Forest to Ely, Tower, Virginia, and return to twin cities via Grand Rapids and Aitkin, or via Duluth.
4. **Forest Trip.** (Forest and lakes three-day trip). Twin cities to Elk River, Milaca, Mille Lacs, Brainerd, Pine River, Walker, Cass Lake, Bemidji, Itasca Park, (State Forest School and Experiment Station) Park Rapids, Wadena, Motley, Little Falls, St. Cloud, Minneapolis and St. Paul.
5. **Ten Thousand Lakes and Fisherman's Trip.** (Three to seven days). Twin cities, Elk River, St. Cloud, Sauk Center, Alexandria, Fergus Falls, Pelican Rapids, Detroit Lakes, Park Rapids, Walker, Brainerd, Mille Lacs, Milaca, Elk River and twin cities.
6. **Minneapolis and Hennepin County Trip.** (Half day). St. Anthony Boulevard, Victory Memorial Drive, Glenwood Parkway, Cedar Lake, Lake of the Isles, Lake Calhoun, Lake Harriet, Minnehaha Parkway, Lake Nokomis, Minnehaha Falls, Fort Snelling, Ford Plant, River Road, University of Minnesota and University Farm.
7. **St. Paul and Ramsey County Trip.** (Half day). State Fair Grounds, Como Park, Wheelock Parkway, Phalen Park, White Bear, Mounds Park, (Indian Mounds), State Fish Hatchery, State Capitol, Summit Avenue, River Boulevard, Ford Plant, University of Minnesota, and University Farm.

Tentative Program of the 21st Annual Meeting of the American Society of Agricultural Engineers

University Farm, St. Paul, Minnesota — June 22 to 25, 1927

June 21—7:00 P.M. Council Meeting—Room 105 Agricultural Engineering Building

First Day — Wednesday, June 22

Morning Program

8:30 A.M. Reception, registration, etc.

Rural Electric Session — 9:30 A.M. — Room 107

Arthur Huntington, chairman, Rural Electric Division, presiding

Reports of Committees—
- (a) Committee on Farm Wiring—B. P. Hess, Chairman
- (b) Committee on Farm Lighting—W. C. Brown, Chairman

PAPER: "Rural Electrification in Europe"—E. A. Stewart, associate professor of agricultural engineering, University of Minnesota.

ADDRESS: H. T. Sands, president-elect, National Electric Light Association

ADDRESS: Paul S. Clapp, managing director, National Electric Light Association

Reclamation Session — 9:30 A.M. — Room 217

Harry B. Roe, chairman, Reclamation Division, presiding

Reports of Committees—
- (a) Committee on Drainage in Humid Regions—Q. C. Ayres, Chairman
- (b) Committee on Drainage of Irrigated Lands—W. W. Weir, Chairman
- (c) Committee on Soil Erosion—G. E. Martin, Chairman
- (d) Committee on Forestry—L. F. Livingston, Chairman
- (e) Committee on Land Clearing—W. A. Rowlands, Chairman
- (f) Committee on Land Settlement and Development—David Weeks, Chairman
- (g) Committee on Irrigation—Geo. S. Knapp, Chairman
- (h) Committee on Run-Off from Agricultural Lands—C. E. Ramser, Chairman
- (i) Committee on Soil Hydraulics—W. P. Miller, Chairman

PAPER: "Subsoil as a Factor in Drainage Design"—S. A. Norling, consulting drainage engineer, Excelsior, Minnesota

Discussion: E. R. Jones, professor of agricultural engineering, University of Wisconsin

Afternoon Program

Rural Electric Session — 1:30 P.M. — Room 107

Arthur Huntington, chairman, Rural Electric Division, presiding

PAPER: "Farm Refrigeration Studies" (Speaker to be selected)

PAPER: "Rural Electrification from the Public Utility Manager's Point of View"—G. C. Neff, general manager, Wisconsin Power and Light Company

PAPER: "Developing Methods and Equipment for Extending the Use of Electricity in Agriculture"—Chas H. Churchill, Jr., manager, Port Henry Light, Heat and Power Company

Discussion of plans for the 1927-28 activities of the Rural Electric Division

Reclamation Session — 1:30 P.M. — Room 217

Harry B. Roe, chairman, Reclamation Division, presiding

PAPER: "Silting of Drainage Ditches—Its Control and Prevention"—R. N. Towl, drainage engineer, Omaha, Nebraska

PAPER: "Influence of Growth on Flow in Open Ditches"—C. E. Ramser, drainage engineer, U. S. Department of Agriculture

PAPER: "Alkali Land Reclamation"—J. C. Marr, associate irrigation engineer, U. S. Department of Agriculture

Discussion of plans for the 1927-28 activities of the Reclamation Division

* * *

5:00 P.M. Kittenball Game (five innings)—Division of Agricultural Engineering, University of Minnesota vs. challengers

6:30 P.M. Picnic supper at University Farm (Minnesota strawberries and cream)

Stunt by agricultural engineering staff, Iowa State College

Stunt by Minnesota Student Branch of A.S.A.E.

Evening Program

8:00 P.M. Group Meetings (By arrangement with Meetings Committee)
- (a) Heads of college agricultural engineering departments
- (b) Land clearing group
- (c) Consulting agricultural engineers
- (d) A.S.A.E. student members

Second Day — Thursday, June 23

Morning Program

General Session — 9:00 A.M. — Auditorium, University Farm

Oscar W. Sjogren, president, presiding

Meeting called to order by William Boss, chairman, Meetings Committee

ADDRESS OF WELCOME: "Significant Changes Taking Place in Agriculture"—W. C. Coffey, dean and director, University of Minnesota, Department of Agriculture

PRESIDENT'S ANNUAL ADDRESS: O. W. Sjogren, chairman, department of agricultural engineering, University of Nebraska

REPORT: "Agricultural Engineering Research—1926"—R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

* * *

11:00 A.M. to 5:00 P.M. Entertainment for Visiting Ladies: Bus trip to Lake Minnetonka, box luncheon at Minnetonka, short boat trip, and return via river drive

Afternoon Program

General Session — 1:30 P.M. — Auditorium, University Farm

Oscar W. Sjogren, president, presiding

ADDRESS: "The Economic and Moral Influence of Drainage and Flood Control on the Community"—John A. Norris, chairman, Texas Board of Water Engineers

ADDRESS: "Engineering and Agriculture"—L. W. Wallace, executive secretary, American Engineering Council

ADDRESS: "Solving the Labor Problem in Farming Operations" —Thos. D. Campbell, president, Campbell Farming Corporation

* * *

4:00 P.M. Field Demonstrations—
- (a) Manless plow
- (b) Automatic plow
- (c) Big team hitch

5.30 P.M. Supper Conferences
- (a) Extension agricultural engineers
- (b) Committee meetings

Evening Program

8:00 P.M. ANNUAL BUSINESS MEETING—Auditorium, University Farm

8:00 P.M. Reception for visiting ladies

Third Day — Friday, June 24

Morning Program

Farm Machinery Session — 9:00 A.M. — Room 107

George W. Iverson, chairman, Farm Power and Machinery Division, presiding

REPORT: "Progress of Correlation in Farm Equipment Research" —H. B. Walker, senior agricultural engineer, U. S. Department of Agriculture

REPORT: "An Analysis of Farm Production Costs from an Engineering Standpoint"—J. B. Davidson, professor of agricultural engineering, Iowa State College

PAPER: "Kinematics and Dynamics of the Wheel-Type Farm Tractor"—E. G. McKibben, junior agricultural engineer, University of California

Farm Structures Session — 9:00 A.M. — Room 217

Deane G. Carter, chairman, Farm Structures Division, presiding

PAPER: "The Relation Between Farm Building Overhead and Cost of Production"—John Swenehart, professor of agricultural engineering, University of Wisconsin

REPORT: "Promotion of Research in Farm Structures"—M. C. Betts, architect, division of agricultural engineering, U. S. Department of Agriculture

Afternoon Program

Farm Machinery Session — 1:30 P.M. — Room 107

George W. Iverson, chairman, Farm Power and Machinery Division, presiding

PAPER: "Mechanical Equipment for the Cultivation of Row Crops"—R. I. Shawl, department of farm mechanics, University of Illinois

PAPER: "A Preliminary Study of the Relation Between Form and Power in the Horse Based on the Pulling Contest Data"—A. E. Brandt, instructor in mathematics, Iowa State College

REPORT: "Results of the Corn Borer Clean-Up Campaign"—C. O. Reed, engineer in charge, U.S.D.A. Corn Borer Control

Reports of Committees

Discussion of plans for the 1927-28 activities of the Farm Power and Machinery Division

Farm Structures Session — 1:30 P.M. — Room 217

Deane G. Carter, chairman, Farm Structures Division, presiding

REPORT: "Developing a Program of Planned Farm Structures Studies"—(Speaker to be selected)

Reports of Committees

Discussion of plans for the 1927-28 activities of the Farm Structures Division

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3:30 P.M. Inspection trip to University experimental peat plots and to Bowman Farm buildings

Evening Program

7:00 P.M. ANNUAL BANQUET (Dining Hall, University Farm) Toastmaster, H. W. Riley, Cornell University

ADDRESS: E. M. Freeman, dean, college of agriculture, forestry and home economics, University of Minnesota

Music and stunts

9:30 P.M. Dancing and cards (informal)

Fourth Day — Saturday, June 25

Morning Program

College Division Session — 8:30 A.M.

H. B. Walker, chairman, College Division, presiding

PAPER: "Some Recent Developments in College Instruction Methods"—Dr. A. V. Storm, University of Minnesota

PAPER: "Agricultural Engineering Department Responsibilities and Relationships in Secondary School Education" —E. W. Lehmann, professor of farm mechanics, University of Illinois

Discussion: M. A. Sharp, Iowa State College

Committee Reports (Five-minute oral report by chairman and five minutes of discussion)

(a) Committee on Student Branches—B. M. Stahl, Chairman
(b) Committee on Motion Pictures — A. J. Schwantes, Chairman
(c) Committee on Cooperative Relation—H. B. Walker, Chairman
(d) Committee on Advancement of Agricultural Engineering Education—Q. C. Ayres, Chairman
(e) Committee on Agricultural Engineering Extension—Ivan D. Wood, Chairman
(f) Committee on Farm Machinery Instruction—R. H. Driftmier, Chairman
(g) Committee on Farm Mechanics in Secondary Schools—E. W. Lehmann, Chairman
(h) Committee on Teaching Methods — C. O. Reed, Chairman
(i) Committee on Aims and Objectives—J. B. Davidson, Chairman
(j) Committee on Five-Year Program for Advisory Committee—M. L. Nichols, Chairman

* * *

12:00 M. Cabinet Luncheon of Council and division chairmen and vice-chairmen to discuss plans for Society year 1927-28

Afternoon Program

College Division Session — 1:30 P.M.

H. B. Walker, chairman, College Division, presiding

PAPER: "A Logical Policy for Juvenile Extension Programs"—Ivan D. Wood, extension agricultural engineer, University of Nebraska

Discussion: F. P. Hanson, University of Illinois, and W. G. Ward, Kansas State Agricultural College

PAPER: "What Agricultural Engineers Can Contribute to Home Economics Instruction"—Eloise Davison, professor of home economics, Iowa State College

Discussion: P. B. Potter, Ohio State University
Deane G. Carter, University of Arkansas
E. W. Lehmann, University of Illinois

Educational Demonstrations—

(a) Farm machinery laboratory instruction by agricultural engineering faculty of Iowa State College
(b) Rural sanitation project—pump installation instruction by agricultural engineering faculty—E. A. Stewart, University of Minnesota

Comments on instruction methods demonstrated—Dr. A. V. Storm, University of Minnesota

The Engineer as a Public Speaker

IN THE course of his address at the annual meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers last December, Thomas D. Campbell said: "We like to get college men on our job. We try to get graduates of technical colleges. I think the time will come when agricultural courses will have more mechanical training in them—and more English."

That thrust was received with a spontaneous burst of laughter at the moment, but since then at least some of those who heard it have been meditating the matter in their hearts. All of which is prefatory to certain remarks by the Hon. George H. Dern, governor of Utah, which appeared in "Engineers and Engineering." He said:

"My observation has been that the engineer in private conversation can scintillate as brightly as a life insurance agent or an oil stock salesman, but before an audience, with rare exceptions, he is a total loss. . . . . . . I have attended meetings at which some topic of general interest to the members was up for discussion, and where an animated debate was the logical thing to expect. After the chairman states the subject and invites discussion, there is dense silence. Finally, a member bolder than the rest gets up and, with trembling voice and knees, makes a motion. The motion carries, the meeting adjourns, and then the members gather into groups and begin to discuss the question seriously and intelligently, giving cogent arguments on either side and embellishing their remarks with appropriate or inappropriate epithets, illustrations and figures of speech.

"Now I am not pleading for more speechmaking. The good Lord knows we have too much of this great American indoor sport already. But I think every man ought to be able and ready to express his opinions at the proper time. . . . . . . The person who has ideas cannot exert any influence by keeping them locked up in his own mind.

"The engineer, with his training of observation and analysis, ought to and does have ideas, and usually they are sound because they are founded upon facts and are carefully reasoned out. The world needs his ideas, and he ought to be equipped to express them at the time and place where they will do the most good. . . . . .

"So long as the engineer remains in his own profession he has to deal almost exclusively with things—with inanimate matter. But when he gets into politics he has to deal with living, breathing human beings. He must know something about how the human mind operates. He finds he cannot do anything for the public unless the public believes in him. . . . . . . If the engineer is to go into politics as I think he should, the curriculum of every engineering school should include a course in public speaking. . . . . . .

"Why doesn't the engineer participate in politics? I suppose one reason is that he is too busy trying to make a living, and the fees in politics are not overly tempting. I am afraid, therefore, that I should be giving engineers bad advice if I advised them to go into politics for the money there is in it. However, it is well known that engineers do not care anything about money. All they want is a chance to serve their fellow man, and so I feel safe in urging them to go in for politics."

AGRICULTURAL ENGINEERING

Established 1920

A journal devoted to the advancement of the theory and practice of engineering as applied to agriculture and of the allied arts and sciences. Published monthly by the American Society of Agricultural Engineers, under the direction of the Publications Committee.

PUBLICATIONS COMMITTEE
S. H. McCrory, Chairman
R. W. Trullinger G. W. Iverson
J. B. Davidson F. A. Wirt

The Society is not responsible for the statements and opinions contained in the papers and discussions published in this journal. They represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

Graphs Preferred to Tables

IT HAS been proposed that A.S.A.E. members, when preparing papers for oral presentation at meetings, but which may later be published in the Journal, or contributions solely for publication, make use of curves or graphs so far as practicable in preference to tables. The point is made that, in the brief time that a chart may be shown or a slide thrown on the screen, those present can much more quickly grasp the significance of the shape of a curve or the slope of a line than they can interpret the significance of a tabulation of figures. Furthermore, the graphical method leaves a vivid visual memory.

When material is published in the Journal the same consideration applies and others are added. In a field as broad as ours the engineer must needs exercise economy of time and effort in pursuing subjects outside his own specialty, and here, too, the speed with which the import of a graph may be grasped and the ease with which it is remembered are valuable. At the same time the more intensive student can take off points with an accuracy sufficient for most purposes.

From the standpoint of publication in the Journal the advantages are all with the graphical method. Not only is tabular matter costly of composition, but the possibilities of error are so great as to constitute an everpresent source of anxiety to the editor, whereas the graph, being reproduced by photographic methods, is necessarily and automatically accurate. It should be noted also that graphs lend themselves readily to the attractive make-up of pages.

It is proper in this connection to point out, to those who may not be familiar with the matter, that blue prints are practically worthless for engraving purposes, although usually satisfactory engravings may be made from tracings. Graphs on closely ruled cross-section paper, even when the color of the ruling is such that it will reproduce satisfactorily, are not nearly so desirable for engraving purposes as copies of such curves in which the scales of ordinates and abscissas are indicated at the margins. Very fine lines are to be avoided especially when the scale must be considerably reduced to bring the graph within the width of a Journal column. Fine lines have an annoying way of being lost just at the most essential places.

In general a graph or line drawing which makes a good lantern slide also makes a good engraving, for the processes of reproduction are essentially similar; moreover, the proportions of height and width suitable for a lantern slide usually are appropriate for the Journal. When lantern slides have been made, a glossy black and white print from the lantern slide negative usually will be entirely satisfactory for engraving purposes, particularly if the requirements of a really good lantern slide have been observed in preparing the original copy.

In setting forth the foregoing general principles, the editor does not want to be construed as objecting to any and all tables. There are some cases in which the subject matter does not lend itself to graphical presentation. It should be noted also that the general objection to tabular matter does not apply to very small tables consisting of only three or four lines with a few items to the line, the import of which may be quickly grasped by the reader, and which present no difficulties in arrangement nor serious possibilities of error to the printer. It might be added that for engraving purposes the drawing ink should be unmistakably black and the paper white, although as stated the blue tint of tracing cloth is photographically equivalent to a moderate whiteness. A smooth rectangular layout without waste space is desirable. Explanatory data are preferably embodied in a printed caption underneath the engraving rather than being lettered on the drawing.

A Movement Toward Engineering Research

ON THE occasion of the opening of the 173rd year of Columbia University, Dr. Charles Lucke made the annual academic address, in the course of which he remarked:

"Through research, engineering makes contact with those other groups each representing something necessary in the world of affairs, the business man and merchant, banker and skilled workman, lawyer and economist.

"There is nowadays no lack of appreciation of the results of engineering research, but generally under other names such as 'discoveries,' 'inventions,' or 'industrial development,' for example. There is also a fast widening public realization that these engineering contributions represent additions to our national wealth of greater importance and of greater magnitude than our so-called natural resources."

Notwithstanding the ability of big business to finance its own research program, much of the most valuable engineering research is being conducted in the engineering laboratories of the state universities and other public or quasi-public agencies. If this is legitimate and in the public interest, and there is no reason to think otherwise, it is even more obvious that research in agricultural engineering, where there are few if any industrial units large enough to carry on research work on a comprehensive scale, should be taken in charge chiefly by the agricultural engineering departments of the land-grant colleges and experiment stations. Not only is it the practical procedure from the standpoint of expediency, but it is in line with the well-established policy in the United States to extend to agriculture a very generous measure of technical assistance.

The Department of Agriculture's survey of research in mechanical farm equipment has given an impetus to agricultural engineering research of certain sorts in the experiment stations, and the departments of agricultural engineering in the stations and the colleges are developing a high standing as engineering research agencies, both in professional and lay circles, which they have so well earned. The members of the American Society of Agriculturals Engineers can serve both the pestige of their profession and the advancement of American agriculture by letting no opportunity pass to promote such recognition.

Coming Into Its Own

IN A letter to the Secretary of the A.S.A.E., Arthur Huntington, chairman of the Rural Electric Division, says:

"The more I think about my recent trip east, the more I am of the opinion that the American Society of Agricultural Engineering has arrived at the place where it can and must take an outstanding place in the engineering world. I spent an evening at the Power Club in New York. The general discussion was a new phase of engineering known as 'agricultural engineering.'"

A. S. A. E. and Related Activities

Col. Zimmerman Elected President

AT THE recent annual election of officers of the American Society of Agricultural Engineers, conducted by secret letter ballot, Col. O. B. Zimmerman, experimental engineer, International Harvester Company, was elected president. Col. Zimmerman will take office immediately following the annual meeting of the Society to be held at University Farm, St. Paul, Minnesota, June 22 to 25, and will serve for one year.

Other officers elected are as follows:

First vice-president, Arthur Huntington, public relations engineer, Iowa Railway and Light Corporation

Second vice-president, Deane G. Carter, professor of agricultural engineering, University of Arkansas

Treasurer, Raymond Olney, St. Joseph, Michigan

Member of the Council, A. H. Hoffman, research specialist in agricultural engineering, University of California

Nominating Committee, H. B. Walker, Kansas State Agricultural College, chairman; George W. Iverson, Advance-Rumely Company; and K. J. T. Ekblaw, consulting agricultural engineer, Chicago.

Meeting Considers Organization of New Section

ON MAY 7 nineteen leading agricultural engineers, members of the American Society of Agricultural Engineers from the seven north central states, met at Brookings, South Dakota, to consider the organization of a section of the American Society of Agricultural Engineers, to be known as the "North Central Section." The states which it is proposed shall comprise this section are: Minnesota, Iowa, Nebraska, Missouri, Kansas, North Dakota and South Dakota.

In three sessions the group completed the preliminary work of organization and heard some committee reports and technical and other papers. R. L. Patty, of South Dakota State College, presided during the morning and afternoon.

The morning session was opened with an address of welcome by Dr. C. W. Pugsley, president of South Dakota State College. Dr. Pugsley is heartily in sympathy with the aims and ideals of the agricultural engineering profession and is largely responsible for the present agricultural engineering department at that institution. In giving a short history of the engineering work at agricultural colleges, he said that it was really started by the Morrill Act of 1862. At that time there were only two branches of engineering, namely, civil and military. He expressed his disapproval of all back-to-the-farm movements, emphasizing that large numbers of people should not spend their lives raising food by crude methods when a much smaller number can do the work with modern machinery. In this connection he prophesied that the country will always have an excess population which must steadily be fed into the industries of the cities. He welcomed the visitors to South Dakota and particularly to the state college at Brookings.

Wm. Boss, of the University of Minnesota, in a discussion of the purpose of the meeting, gave the following as the reasons why the proposed North Central Section of the Society should be organized:

1. Because this year it is to be the host to the annual meeting of the Society in June.
2. To promote contact between agricultural engineers within the section
3. To give opportunity for development of the younger members of the society
4. To help "sell" agricultural engineering

Prof. Boss felt that in the past not enough attention had been given to this last point.

J. B. Davidson, of Iowa State College, discussed the matter of the committee work of the section. He suggested committees on resolutions, executive, nominations, and publicity. It was his opinion that the section should minimize the number of its committees and that it should appoint no technical committees, inasmuch as such work is taken care of by the technical divisions of the Society.

Constitution and By-Laws for the proposed section,* having been previously drafted by a special committee, were presented and read by E. M. Mervine, Iowa State College, and were subsequently adopted. A petition signed by nineteen members of the Society requested that permission be granted by the Council for the organization of the section.

"The Relationship of the Section to the Parent Society" was the topic of a discussion by O. W. Sjogren, president of the Society. In it he presented the ideas that one purpose of the sectional organization should be to promote membership, that it should handle largely sectional problems, and that it should cooperate with the parent society in every way and promote loyalty and interest in it.

The business of the morning was completed with the appointment of a nominating committee.

E. A. Stewart, of the University of Minnesota, gave a report on "Rural Electrification in Minnesota," and Dr. Pugsley explained the main features of the new library building at South Dakota State College before the morning session adjourned.

At luncheon C. Larson, dean of agriculture, and H. M. Crothers, dean of engineering at South Dakota State College, made a few pointed remarks which showed that they appreciated the need of agricultural engineering and are in sympathy with the American Society of Agricultural Engineers.

Organization details took up the full afternoon. The following officers were elected: R. L. Patty, chairman; E. M. Mervine, first vice-chairman; M. M. Jones, second vice-chairman; E. A. Stewart, secretary-treasurer.

J. F. Goss presided at the evening session. Mr. Huntemer, secretary of the Brookings Commercial Club, again welcomed the visitors. Technical talks and papers were given as follows: "The Land Clearing Situation in Minnesota," A. J. Schwantes; "The Combine Harvester in the North Central United States," R. H. Black; "Harvesting Corn Stalks for Commercial Purposes," E. V. Collins.

The business of the day was completed when a report of the resolutions committee was read and accepted.

Much desirable publicity was obtained incident to the meeting. The Brookings papers gave it several good write-ups, both before and after it was held. A brief but pithy editorial in one of these papers shows the attitude which thinking laymen are beginning to take toward this new profession. It is as follows:

"The interest which has been manifested in the meeting of agricultural engineers of seven states at state college next week is evidence of the advance which this branch of engineering has made in the last few years. It was not so long ago that agricultural engineering was looked upon as little more than a fad, but the part it has played in improving farm methods has amply proved its worth."

Such public and unsolicited recognition of the accomplishments of the profession is significant of the fact that the profession is firmly established.

An Award for a Slogan

THE Power Transmission Association announces it will make an award of $250.00 to be announced at the National Industrial Advertising Association convention in Cleveland, June 16, 1927, for the best slogan and design for the association which is received on or before June 4, 1927.

The wording should typify the object of the association in briefest possible words, with a striking action design showing some application of or relating to mechanical power

transmission. What is desired is something effective and striking as "Save the Surface" or "Say it with flowers," or similar emblems. Ideas are wanted, not necessarily a finished emblem.

The object of the Power Transmission Association is to determine and foster the right drive or use of mechanical power transmission for any given installation in any factory, shop, or place where power is used to drive machines. That is, the most efficient and economical use of mechanical power transmission mediums. By mechanical power transmission mediums is meant belts and pulleys, shafting, gears, clutches, chains, or any form of transmitting power mechanically.

Send your ideas, sketches, suggestions, etc., for this $250.00 award for a slogan emblem to Power Transmission Association, Drexel Building, Philadelphia, Pennsylvania, on or before June 4, 1927.

Home Economics Meeting

THE twentieth annual meeting of the American Home Economics Association will be held at Asheville, North Carolina, June 21 to 24, 1927. Detailed information relative to the meeting and program to be presented will be given out at a later date.

New A.S.A.E. Members

Joseph L. Baker, salesman and demonstrator, International Harvester Co., Peoria, Illinois.

Walter K. Clore, manager, Compania Central Altagracia, Ingenio Oriente, Oriente, Cuba.

H. Warren Denison, assistant ventilation engineer, The Louden Machinery Co., Fairfield, Iowa.

Frank W. Flack, Iowa Railway & Light Corporation, Cedar Rapids, Iowa.

F. H. Higgins, research department, National Association of Farm Equipment Manufacturers, Chicago, Illinois.

Arthur C. Jenvey, general sales manager, Western Harvester Co., Stockton, California.

Frederic A. Lyman, research assistant, National Association of Farm Equipment Manufacturers, Chicago, Illinois.

Francis G. North, lecturer, MacDonald College, Quebec, Canada.

Gladstone Reed, consulting farm manager, United Bank & Trust Co., Fresno, California.

Bertram D. Scott, sales manager, Louden Machinery Co., Fairfield, Iowa.

H. C. Wallace, sales manager, Link Mfg Co., Kansas City, Missouri.

Frank G. Wells, manager, Olson Mfg. Co., Albert Lea, Minnesota.

Transfer of Grade

Raymond P. Frey, instructor, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

James Leonard Clark, secretary and treasurer, Clarke Publishing Co., Madison, Wisconsin.

Cecil Leon East, extension engineer, Penn Central Light & Power Co., Altoona, Pennsylvania.

Maximillian Fleischer, secretary and general superintendent, Inglewood Farms, Inc., Gordonsville, Virginia.

M. F. McCarty, branch manager, International Harvester Co., Aurora, Illinois.

John Q. McDonald, agriculturist, Caterpillar Tractor Co., San Leandro, California.

Graydon Oliver, technical editor, Petroleum World Publishing Co., Los Angeles, California.

Otto Schnellbach, studying American agricultural engineering, Messrs. Nash, Watjen & Banks, Ltd., 72 Wall Street, New York City.

Willis L. Towne, advertising executive, General Electric Co., Schenectady, New York.

Transfer of Grade

Harris Pearson Smith, teaching, Texas A & M College, College Station, Texas. (Associate Member to Member)

Robert Holcomb Smith, head of department of farm mechanics, New York State School of Agriculture, Canton, New York. (Associate Member to Member)

Employment Bulletin

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members as well as members, are privileged to use the "Positions Open" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER available. Seventeen years experience in the designing and manufacture of farm tractors, motor trucks, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER, graduate of University of Illinois, nine years teaching experience as assistant professor in one of the largest universities of the central west. Eleven years manufacturing experience with one of the large tractor and farm implement builders. Experienced in production, design, and management. Desires position preferably as extension agricultural engineer or experimental or production manager work. MA-133.

AGRICULTURAL ENGINEER, 1924 graduate of University of Wisconsin, desires permanent connection. Past experience includes tree surgery and tractor motor inspection. Prefers duty on private estate or investigational work. Edwin A. Bier, 515 N. Church St., Rockford, Ill.

AGRICULTURAL ENGINEER wants responsible position in Canada in experimental or engineering work. Experienced wood patternmaker and draftsman. Eight years with present employers as patternmaker and later in charge of experimental work. Age 35 years and married. Wants position with better opportunity for growth. MA-139.

AGRICULTURAL ENGINEER, 1925 graduate of Kansas State Agricultural College in agricultural engineering, now serving second year as instructor of farm mechanics in an agricultural school, desires position in experimental or extension work in agricultural engineering. Arrange for interview at A.S.A.E. annual meeting at St. Paul. Age 28. Married. MA-140.

AGRICULTURAL ENGINEER, graduate of Iowa State College in both agriculture and agricultural engineering. Ten years farm experience and nine years in engineering, extension, and teaching work. Prefers location on the Pacific coast with a permanent residence, experimental work, management of a ranch, or college teaching. Dependable and responsible. MA-141.

Positions Open

SALES MANAGER OR ASSISTANT SALES MANAGER WANTED. Agricultural engineer with sales experience preferred. Ample opportunity for advancement. Business now doing $500,000 volume on a varied line of farm equipment items in ten central western states. PO-122.

AGRICULTURAL ENGINEER, recent graduate, wanted by farm equipment manufacturer to take over work of demonstrating and introducing new tractor guide. Must be able to handle tractors in the field, make some designs, take orders, and eventually look after advertising and sales. PO-123.

SUPERINTENDENT wanted for a plow and tillage implement plant in Illinois. A competent and experienced man who has had some technical training is required. PO-124.

DESIGNER in engineering department of a plow and tillage implement plant in Illinois wanted. Man with technical education and two or three years experience required. PO-125

ADVERTISING MAN wanted with experience in the farm equipment business. Must have executive ability. Someone with motor truck experience preferred. PO-126.

AGRICULTURAL ENGINEER wanted as instructor in farm motors and drainage. Single man who can also act as preceptor of boys' dormitory. Splendid opportunity for senior or graduate agricultural engineer who wants practical teaching experience. School term October 1 to April 1. Write A. C. Heine, Agricultural Engineer, West Central School of Agriculture, Morris, Minnesota.

AGRICULTURAL ENGINEER with ability along experimental and engineering lines wanted by a farm machinery manufacturer in the middle west. Should have training as a draftsman. Recent graduate preferred. PO-130.